

City of Marco Island



TECHNICAL SPECIFICATIONS

Marco Lakes ASR Raw Water Pumps' Replacement



AECOM

March 2013

TABLE OF CONTENTS

DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS

00301 Proposal Bid Form

DIVISION 1 - GENERAL REQUIREMENTS

01010 Summary of Work
01045 Cutting, Coring and Patching
01046 Control of Work
01080 Abbreviations and Definitions
01090 Reference Standards
01172 Variable Frequency Drive Unit
01300 Submittals
01310 Construction Progress Schedule
01380 Construction Photographs
01400 Quality Assurance
01500 Temporary Facilities
01568 Erosion Control, Sedimentation and Containment of Construction
Materials
01600 Control of Materials
01610 Delivery, Storage and Handling
01700 Contract Closeout
01710 Cleaning Up
01730 Operation and Maintenance Data
01740 Warranties and Bond

DIVISION 2 - SITE WORK

02050 Demolition and Alterations
02100 Site Preparation
02210 Earth Excavation, Backfill, Fill and Grading
02615 Ductile-Iron Pipe and Fittings

DIVISION 3 - CONCRETE

03100 Concrete Formwork
03200 Concrete Reinforcement
03300 Cast-In-Place Concrete
03732 Existing Concrete Preparation

DIVISION 4 - MASONRY - (NOT USED)

DIVISION 5 – METALS - (NOT USED)

DIVISION 6 - WOOD AND PLASTIC - (NOT USED)

TABLE OF CONTENT (Cont.)

DIVISION 7 - THERMAL AND MOISTURE PROTECTION - (NOT USED)

DIVISION 8 - DOORS AND WINDOWS - (NOT USED)

DIVISION 9 – FINISHES – (NOT USED)

DIVISION 10 - SPECIALTIES - (NOT USED)

DIVISION 11 - EQUIPMENT

11301 Vertical Turbine Pumps and Appurtenances

DIVISION 12 – FURNISHING - (NOT USED)

DIVISION 13 - SPECIAL CONSTRUCTION

13120 Custom Pre-Engineered Building (Marco supplied spec)

13300 Utility Control Instrumentation System

13300A Instrument Data Sheets

DIVISION 14 - CONVEYING SYSTEMS – (NOT USED)

DIVISION 15 - MECHANICAL

15056 Pipe Supports

15101 Process Valves and Appurtenances

15370 Process Piping and Appurtenances

DIVISION 16 - ELECTRICAL

16050 Electrical Work - General

16110 Electrical Raceway System

16120 Electric Wires and Cables

16140 Wiring Devices

16160 Panel Boards

16402 Underground Distribution System

16450 Grounding

16521 Exterior Site Lighting

16900 Electrical Controls and Miscellaneous Electrical Equipment

16999 Field Acceptance Test

END OF SECTION

BID FORM
CITY OF MARCO ISLAND
MARCO LAKES ASR RAW WATER PUMPS' REPLACEMENT

If this proposal is accepted, the undersigned Bidder agrees to bring to final completion within 180 CALENDAR DAYS after the effective date established in the "Notice to Proceed" for the Base Bid Items. Unit price prevails over Total Price. All bid items shall include costs for furnishing to the OWNER all materials, and supplies, and for all costs incurred in completing the work, including the installation of all materials, equipment, and supplies furnished, all other labor, permit fees, taxes, insurance, miscellaneous costs, overhead and profit for the **Marco Lakes ASR Raw Water Pumps' Replacement**.

SCHEDULE OF BID ITEMS

ITEM NO	DESCRIPTION	EST QTY	UNITS	UNIT COST	VALUE
1	Mobilization/Demobilization including all permit fees	1	L.S.		
2	Demolition	1	L.S.		
3	Furnish & install 14-inch D.I.P. including restrained joints and ductile iron fittings	65	L.F.		
4	Furnish & install 14-inch pump control and pressure reducing valve	2	Each		
5	Furnish & install 14-inch gate valve	2	Each		
6	Furnish & install air relief gate valve	2	Each		
7	Furnish & install 14-inch D.I.P. including restrained joints and ductile iron fittings	55	L.F.		
8	Furnish & install 24" x 14" tee	1	Each		
9	Furnish & install 24-inch D.I.P. including restrained joints and ductile iron fittings	12	L.F.		
10	Furnish & install concrete slab including reinforcement	450	S.F.		
11	Furnish & install all pipe supports	1	L.S.		
12	Design, furnish & install custom pre-engineered bldg	1	L.S.		
13	Install pumps with motors and furnish & install all appurtenances including but not limited to column pipe	2	Each		
14	Furnish & install all electrical labor and materials not included with equipment listed herein.	1	L.S.		

ITEM NO	DESCRIPTION	EST QTY	UNITS	UNIT COST	VALUE
15	Furnish & install all flow and level monitoring instruments	1	L.S.		
16	Furnish & install PLC and enclosures, I/O and accessories; install VFDs as indicated and specified	1	L.S.		
17	Furnish and install any additional monitoring or control devices as indicated by drawings or specifications to ensure a complete and functional system	1	L.S.		
18	Provide on site startup and commissioning assistance to the owner/engineer to ensure a complete and functional system	1	L.S.		
19	Furnish & install all instrumentation, cables, and controls materials not included with equipment listed herein.	1	L.S.		
20	Provide for all testing as required by the Contract Documents	1	L.S.		
21	For payment of Performance Bond and Payment Bond premiums and consideration for indemnification to OWNER under the General Conditions and the Supplementary Conditions hereto (shall not exceed 3% of total project cost)	1	L.S.		

**GRAND TOTAL BASE BID
(ITEM NO. 1 THROUGH 21)**

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Written

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 LOCATION OF WORK:

- A. The work of this Contract is located on the mainland of Collier County in an area owned by the City of Marco Island, at the Marco Lakes surface water and raw water pumping facility, which also serves as aquifer storage and recovery (ASR).

1.02 SCOPE OF WORK:

- A. Furnish all equipment and incidentals necessary, complete and ready for operation as specified herein.
- B. The Work includes, but is not necessarily limited to, the following major items:
 - 1. Pumping Station:
 - a. Replace two (2) existing raw water pumps and install two (2) new vertical turbine pumps.
 - b. Install variable frequency drives and controls and furnish and install associated electrical and instrumentation work.
 - c. Demolition of the walls of existing pump station walls.
 - d. Pre-fab metal building
 - e. New floor slab to accommodate new pumps.
 - 2. Yard piping

1.03 WORK BY OTHERS:

- A. The following work will be performed by others concurrently with the Work of this Contract.
 - 1. Pumps, motors, and VFDs furnished by Owner of ASR Raw Water pumping station.

2. Asbestos survey by Owner. Contractor to assume there is no asbestos present in for existing building demolition when bidding this project.

1.04 WORK SEQUENCE:

- A. There is no requirement for the maintaining the operation of the pumping station throughout the duration of the project.

1.05 PERMITS

- A. All permits to be obtained by the Contractor. All fees to be paid by the Contractor.

END OF SECTION

SECTION 01045

CUTTING, CORING AND PATCHING

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This Section covers the cutting, coring, rough and finish patching of holes and openings in existing and new construction.
- B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.

1.02 RELATED WORK:

- A. Section 02050: Demolition and Alterations
- B. Section 03300: Cast-In-Place Concrete
- C. Section 03730: Concrete Repair Work
- D. Section 03732: Existing Concrete Preparation

1.01 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400.
- B. Adhere strictly to the manufacturer's current printed recommendations regarding temperature at time of application for all work involving epoxy, cement base coating and protective coating.
- C. Use only products of the specified Repair Mortar System Manufacturer(s) or equal.
- D. Any changes in the specified repair mortar work methods shall be allowed only with the written approval of the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete repair mortar shall be a non-shrink, commercial formulation requiring only the addition of water with minimum 28-day compressive strength of 5,000 psi.

- B. Provide a non-shrink cementitious repair mortar material as manufactured by:
 - a. Sika Repair 224 manufactured by Sika Corp.,
 - b. EMACO S88CI manufactured by Master Builder, Inc.,
 - c. Underlayment F-120 by Sauereisen, Inc.,
 - d. Or equal.
- C. Materials for finish patching shall be equal to those of adjacent construction.

PART 3 - EXECUTION

3.01 GENERAL:

- A. All cutting and coring shall be performed in such a manner as to limit the extent of patching.
- B. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. No structural members shall be cut without approval of the Structural Engineer of Record and all such cutting shall be done in a manner directed by him. No holes may be drilled in beams or other structural members. All work shall be performed by mechanics skilled in this type of work.
- C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown. Finish patching shall match existing surfaces as approved.

3.02 CUTTING:

- A. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.
- B. Corners of square or rectangular openings shall be cored. Do not overcut corners of openings. Corners shall be chipped out square, if required, so as not to cause cracking at the corners.
- C. Provide for control of slurry generated by sawing operation on both sides of element.
- D. When cutting reinforced concrete, the cutting shall be done so as not damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- A. Adequate bracing and/or shoring of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- B. Provide equipment of adequate size to remove cut panel.

3.03 CORING:

- A. Coring shall be performed with an approved non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeve, equipment or mechanical seals to be installed.
- B. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.
- C. Slurry or tailings resulting from coring operations shall be removed from the area following drilling.

3.04 PATCHING:

- A. Prepare surfaces to receive cementitious repair mortar in accordance with manufacturer's instructions.
- B. Mix the cementitious repair mortar material components in accordance with the manufacturer's instructions. Concrete surfaces should be surface saturated dry (SSD) with no standing water prior to mortar application.
- C. Work a wet scrub coat of the mortar per the manufacturer's recommendations into the pores and voids in the substrate and over the substrate prior to mortar application by trowel.
- D. Apply the cementitious repair mortar using a steel trowel to work the material into the surface. Fill voids from deepest to shallowest areas as the application work proceeds. Strictly follow the manufacturer's application requirements.
- E. Once the repair areas are filled with repair mortar, strike off the mortar level with the surrounding concrete substrate. Do not leave a broom finish. Finish with a steel trowel until closed up at the surface and flat.
- F. Cure the repair mortar in strict accordance with the manufacturer's instructions.

END OF SECTION

SECTION 01046

CONTROL OF WORK

PART 1 - GENERAL

1.01 PLANT AND HOURS OF CONSTRUCTION:

- A. Furnish plant and equipment which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the Contract Time. If at any time such plant appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the plant equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.
- B. Normal construction activity shall take place only between the hours of 7 a.m. to 6 p.m., excluding Saturdays, Sundays, and legal holidays. Work outside the above time periods will be permitted only on an emergency basis and only with the approval of the Owner.

1.02 OCCUPYING PRIVATE LAND:

- A. The Contractor shall not (except after written consent from the proper parties) enter or occupy with men, tools, materials, or equipment any land outside the rights of way or property of the Owner. A copy of the written consent shall be given to the Engineer.

1.03 PIPE LOCATIONS:

- A. Exterior pipelines will be located substantially as indicated on the Drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings, etc., are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

1.04 DIMENSION OF EXISTING STRUCTURES

- A. Where the dimensions and locations of existing structures are of importance in the installation or connection of any part of the Work, the Contractor shall verify such dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

1.05 OPEN EXCAVATIONS:

- A. All open excavations shall be adequately safeguarded by providing temporary barricades, fencing, caution signs, lights, and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight.
- B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be well lighted at night.

1.06 TEST PITS:

- A. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer.

1.07 CARE AND PROTECTION OF PROPERTY:

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in other manner acceptable to the Engineer.

1.08 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES:

- A. The Contractor shall assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired by him at his expense.

- B. Assistance will be given the Contractor in determining the location of existing services. The Contractor, however, shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines, and sewers). Services to buildings shall be maintained, and all costs or charges resulting from damage thereto shall be paid by the Contractor.
- A. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the Total Price Bid in the Bid Form.

1.9 COOPERATION WITHIN THIS CONTRACT:

- A. All firms or persons authorized to perform any work under this Contract shall cooperate with General Contractor and his Subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.10 CLEANUP AND DISPOSAL OF EXCESS MATERIAL:

- A. During the course of the work, the Contractor shall keep the site of his operations in as clean and as neat a condition as is possible. He shall dispose of all residue resulting from the construction work and, at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.
- B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor and his subcontractors shall comply with all applicable Federal, State, and local laws, and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in the Specifications.
- C. The Contractor is advised that the disposal of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the Contractor will be required to remove the fill at his own expense and restore the area impacted.

END OF SECTION

SECTION 01080

ABBREVIATIONS AND DEFINITIONS

PART 1 - GENERAL

1.01 RELATED SECTIONS:

- A. Section 01090: Reference Standards

1.02 ABBREVIATIONS:

- A. Where any of the following abbreviations are used in the Contract Documents, they shall have the meaning set forth opposite each. Abbreviations for trade associations and standards organizations are listed in Section 01090 - Reference Standards.

AASHTO American Association of State Highway and Transportation Officials

ACI American Concrete Institute

AFBMA Anti-Friction Bearing Manufacturers Association

AGA American Gas Association

AGMA American Gear Manufacturers Association

AISC American Institute of Steel Construction

AMCA Air Moving and Conditioning Association

ANS American National Standard

ANSI American National Standards Institute

API American Petroleum Institute

ASCE American Society of Civil Engineers

ASHRAE American Society of Heating, Refrigerating and Air Conditioning
Engineers

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

AWG	American or Brown and Sharpe Wire Gage
AWPA	American Wood-Preservers' Association
AWWA	American Water Works Association
CS	Commercial Standard
IBR	Institute of Boiler and Radiator Manufacturers
IEEE	Institute of Electrical and Electronics Engineers, Inc.
Fed. Spec.	Federal Specifications issued by the Federal Supply Service of the General Services Administration, Washington, D.C.
IPS	Iron Pipe Size
JIC	Joint Industry Conference Standards
NBS	National Bureau of Standards
NEC	National Electrical Code; latest edition
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Thread
OS&Y	Outside screw and yoke
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
Stl. WG	U. S. Steel Wire, Washburn and Moen, American Steel and Wire or Roebling Gage
UL	Underwriters' Laboratories
USS Gage	United States Standard Gage
WOG	Water, Oil, Gas
WSP	Working steam pressure

125-lb. ANS American National Standard for Cast-Iron
or Pipe Flanges and Flanged Fittings,
250-lb. ANS Designation B16.1-1975, for the appropriate class

- B. For the purposes of these specs, Contractor and Equipment Supplier are the same and are used interchangeably.

1.03 DEFINITIONS:

- A. Wherever the words defined in this section or pronouns used in their stead occur in the Contract Documents, they shall have the meanings herein given.

As Directed, as Required, Etc.

Wherever in the Contract Documents, or on the Drawings, the words "as directed," "as ordered," "as requested," "as required," "as permitted," or words of like import are used, it shall be understood that the direction, order, request, requirement, or permission of the Engineer is intended. Similarly, the words "approved," "acceptable," "suitable," "satisfactory," and words of like import shall mean approved by, acceptable to, suitable to, or satisfactory to the Engineer.

Provide

Wherever in the Contract Documents the word "provide" is used, it shall mean to furnish (or supply) and install.

Elevation

The figures given on the Drawings or in the other Contract Documents after the word "elevation" or abbreviation of it shall mean the distance in feet above the datum adopted by the Engineer.

Rock

The word "rock," wherever used as the name of an excavated material or material to be excavated, shall mean only boulders and pieces of concrete or masonry exceeding 1 cu. yd. in volume, or solid ledge rock which, in the opinion of the Engineer, requires, for its removal, drilling and blasting, wedging, sledging, barring, or breaking up with a power-operated tool. No soft or disintegrated rock which can be removed with a hand pick or power-operated excavator or shovel, no loose, shaken, or previously blasted rock or broken stone in rock fillings or elsewhere, and no rock exterior to the maximum limits of measurement allowed, which may fall into the excavation, will be measured or allowed as "rock."

Earth

The word "earth", wherever used as the name of an excavated material or material to be excavated, shall mean all kinds of material other than rock as above defined.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01090

REFERENCE STANDARDS

PART 1 - GENERAL

1.01 QUALITY ASSURANCE:

- A. Should specified reference standards conflict with the Contract Documents, refer to paragraph 3.02 of the General Conditions.

1.02 SCHEDULE OF REFERENCES:

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AABC	Associated Air Balance Council 1000 Vermont Avenue, N.W. Washington, DC 20005
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W. Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1101 Connecticut Avenue, N.W., Suite 700 Washington, DC 20036
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
ADC	Air Diffusion Council 230 North Michigan Avenue Chicago, IL 60601
AGA	American Gas Association
AGC	Associated General Contractors of America 1957 E Street, N.W. Washington, DC 20006

AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AIA	American Institute of Architects 1735 New York Avenue, N.W. Washington, DC 20006
AISC	American Institute of Steel Construction Eighth Floor 400 North Michigan Avenue Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
AITC	American Institute of Timber Construction 333 W. Hampden Avenue Englewood, CO 80110
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
APA	American Plywood Association Box 11700 Tacoma, WA 98411
API	American Petroleum Institute 1220 L. Street, N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 1501 Wilson Boulevard Arlington, VA 22209
ASCE	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASPA	American Sod Producers Association 4415 West Harrison Street Hillside, IL 60162
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWI	Architectural Woodwork Institute 2310 South Walter Reed Drive Arlington, VA 22206
AWPA	American Wood-Preservers' Association 7735 Old Georgetown Road Bethesda, MD 20014
AWS	American Welding Society 550 LeJeune Road, N.W. Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BIA	Brick Institute of America 11490 Commerce Park Drive Reston, VA 22091
BOCA	BOCA International Headquarters Office 4051 West Flossmoor Road Country, Club Hills, IL 60478-5795
CDA	Copper Development Association 57th Floor, Chrysler Building 405 Lexington Avenue New York, NY 10174

CLFMI	Chain Link Fence Manufacturers Institute 1101 Connecticut Avenue, N.W. Washington, DC 20036
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195
DHI	Door and Hardware Institute 7711 Old Springhouse Road McLean, VA 22101
EJCDC	Engineers' Joint Contract Documents Committee American Consulting Engineers Council 1015 15th Street, N.W. Washington, DC 20005
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
FGMA	Flat Glass Marketing Association 3310 Harrison White Lakes Professional Building Topeka, KS 66611
FM	Factory Mutual System 1151 Boston-Providence Turnpike P.O. Box 688 Norwood, MA 02062
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WRSIS) Washington Navy Yard, Building 197 Washington, DC 20407
GA	Gypsum Association 1603 Orrington Avenue Evanston, IL 60201
JIC	Joint Industrial Council c/o National Machine Tool Builders Association 79-1 Westpark Drive McLean, VA 22102

IBR	Institute of Boiler and Radiator Manufacturers a/k/a Hydronics Institute P.O. Box 218 35 Russo Place Berkeley Heights, NJ 07922
ICBO	International Conference of Building Officials 5360 S. Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association Box 1568 Carrollton, GA 30112
IEEE	Institute for Electrical and Electronics Engineers 3 Park Ave 17 th Floor New York, NY 10016-5997
IMIAC	International Masonry Industry All-Weather Council International Masonry Institute 815 15th Street, N.W. Washington, DC 20005
MBMA	Metal Buildings Manufacturer's Association 1230 Keith Building Cleveland, OH 44115
MEC	Massachusetts Electric Code
MIL	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
ML/SFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NCMA	National Concrete Masonry Association P.O. Box 781 Hendron, VA 22070

NEBB	National Environmental Balancing Bureau 8224 Old Courthouse Road Vienna, VA 22180
NEC	National Electric Code
NECA	National Electrical Contractors Association 3 Belhesda Metro Center Suite 1100 Bethesda, MD 20814
NEMA	National Electrical Manufacturers' Association 1300 N 17 th Street Suite 1847 Rosslyn VA 22209
NETA	InterNational Electrical Testing Association 106 Stone St. P.O. Box 687 Morrison, CO 80465
NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
NFPA	National Forest Products Association 1619 Massachusetts Avenue, N.W. Washington, DC 20036
NSWMA	National Solid Wastes Management Association 1730 Rhode Island Avenue, N.W. Washington, DC 20036
NTMA	National Woodwork Manufacturers Association 205 W. Touhy Avenue Park Ridge, IL 60068
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PCI	Prestressed Concrete Institute 201 North Wells Street Chicago, IL 60606

PS	Product Standard U.S. Department of Commerce Washington, DC 20203
RIS	Redwood Inspection Service One Lombard Street San Francisco, CA 94111
RCSHSB	Red Cedar Shingle and Handsplit Shake Bureau 515 116th Avenue Bellevue, WA 98004
SDI	Steel Deck Institute P.O. Box 9506 Canton, OH 44711
SDI	Steel Door Institute 712 Lakewood Center North 14600 Detroit Avenue Cleveland, OH 44107
SIGMA	Sealed Insulating Glass Manufacturers Association 111 East Wacker Drive Chicago, Il 60601

END OF SECTION

SECTION 01172

VARIABLE FREQUENCY DRIVE UNIT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. ~~Provide complete simplex type variable frequency drive (VFD) units in a protected chassis as specified.~~
- B. This section covers the work necessary to ~~furnish and~~ install complete variable frequency drives (VFD) furnished by the Owner. ~~Variable frequency drive unit shall be rated 515 Ampere output at 480VAC three phase, and have the capability of operating as a 6 pulse or 12 pulse drive via removal of phase jumper connection and addition of an external input transformer. Provide a drive configured for 6 pulse operation.~~ The drive shall be able to operate a 400 HP motor.
- C. ~~VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.~~
- D. ~~Provide Underwriter's Laboratories listed drive components where applicable.~~

1.02 RELATED WORK:

- A. ~~Section 01171: Electric Motors~~
- B. Section 11301: Vertical Turbine Pumps and Appurtenances

1.03 REFERENCES:

- A. Underwriter's Laboratories Inc. (U.L.):
 - 1. UL-508 Electrical Industrial Control Equipment.
- B. National Electrical Manufacturers Association (NEMA): MG 1.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA-70 National Electric Code.

1.04 SUBMITTALS:

- A. ~~Shop Drawings: Submit the following in accordance with Section 01300-~~
SUBMITTALS:

1. ~~Shop Drawings: Provide a complete list of equipment components, and materials, including manufacturer's descriptive and technical literature, and catalog cuts.~~
 - a. ~~Provide data to verify that drives can be used for motor lead lengths up to 100 feet without output filters. Include information from the VFD manufacturer or output filter or reactor manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG-1, section 31.40.4.2, are met.~~
 - b. ~~Provide chassis enclosure drawings and details showing all dimensions and construction details.~~
2. ~~Harmonic Analyses Report: Provide harmonic analysis report with bid to indicate expected harmonics from individual VFDs and with drives operating at the same time. Operation will be for two 400Hp.~~
3. ~~Submit information with the bid relative to location and expertise of local service office and personnel. Provide a confirmation on the VFD manufacturer's letterhead that bidder and service company are specifically authorized and supported for sale and service of this equipment for the water and wastewater industry.~~
4. ~~Submit a letter with the bid on manufacturer's letterhead stating that the VFD proposed meets or exceeds a 25-year mean time between failure (MTBF) statistic.~~
5. ~~For informational purposes only, submit manufacturer's printed installation instructions.~~
6. ~~Spare Parts Data: Submit a list of spare parts for the equipment specified.~~
7. ~~Operating and Maintenance Instruction Manuals:~~
 - a. ~~Furnish:~~
 - (1) ~~Operating instruction manuals outlining step-by-step procedures required for system startup and operation.~~
 - (2) ~~Manufacturer's name, model number, service manual parts list.~~
 - (3) ~~Brief description of equipment and basic operating features.~~
 - (4) ~~Maintenance instruction manuals outlining maintenance procedures.~~
 - (5) ~~Troubleshooting guide listing possible breakdown and repairs.~~
 - (6) ~~Point-to-point connection wiring diagram for the system.~~

1.05 ~~QUALITY ASSURANCE:~~

~~A. Services of Service Engineer, specifically trained on type of equipment specified.
Man-day requirements listed exclusive of travel time.~~

~~1. Start-up and testing.~~

~~_____5_____ man days.~~

~~2. Man-day is defined as one 8-hour day, excluding travel time.~~

1.06 DELIVERY, STORAGE AND HANDLING:

A. ~~Shipping:~~

~~1. _____ Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.~~

~~2. _____ Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.~~

~~3. Deliver spare parts to Owner.~~

B. Storage and handling:

1. Owner will inspect and inventory items upon delivery to site. Contractor to provide protection during storage and handling as to not damage unit.

1.07 ~~WARRANTY AND SERVICE:~~

~~A. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months after start-up, not to exceed 30 months from date of shipment to the Owner, and in this time period include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers.~~

PART 2 - PRODUCTS

2.01 ~~MANUFACTURERS:~~

~~A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.~~

~~B. Variable Frequency Drive Units:~~

1. ~~Yaskawa Electric America by ICON Technologies~~
2. ~~Or acceptable pre-evaluated and approved product.~~

2.02 HARMONIC ANALYSIS:

- A. ~~The VFD manufacturer shall provide a harmonic analysis model to show predicted harmonic conditions for the as installed drive(s).~~

2.03 PROVISIONS:

A. Service Conditions:

1. ~~Ambient Temperature Range: 0 deg. C to 40 deg. C.~~
2. ~~Operational Humidity: Up to 95 percent non-condensing.~~
3. ~~Environment: As indicated on enclosure schedule.~~
4. ~~Altitude: Below 3,300 ft. above sea level.~~
5. ~~Input Power:~~
 - a. ~~Nominal voltage—460 volts (plus 10 percent or minus 10 percent), 3 phase, 3 wire~~
 - b. ~~Nominal Frequency—60 Hertz (plus or minus 2 Hz.)~~

B. Drive System: 400 HP Units

1. General:

- a. ~~Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a dual full wave rectifier allowing for both 6 and 12 pulse operation via the removal of phase jumper connections. VFDs with external and separate rectifier assemblies to facilitate 12 pulse operation will not be considered. To prevent input line notching, a 5% input reactor shall be provided as part of the VFD protected chassis along with the DC bus capacitors. Insulated Gate Bipolar Transistors (IGBT) shall be employed as the output switching devices to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.~~

- ~~b. The VFD shall have a 5% input line reactor mounted integrally to the VFD enclosure.~~
- ~~c. All components of the drive shall be designed and sized for the normal condition of continuous operation of the driven equipment~~
- ~~d. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.~~
- ~~e. The unit shall withstand drive output terminal line to line and line to ground short circuits without component failure during start up and during operation. Drive to safely shutdown until short is cleared.~~
- ~~f. For inverter rated squirrel cage motors, per NEMA Standard MG-1, part 31.40.4.2, the following limit values at the motor terminals are to be observed:
 - (1) For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.~~
- ~~g. The VFD manufacturer shall guarantee that the above voltage limits will be met with the motor installed up to 100 cable feet from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, it shall be noted in the shop drawing submittal.~~
- ~~h. The drive unit shall be of modular design to provide for ease and speed of maintenance.~~
- ~~i. Provide NEMA 12 aluminum powder coated enclosures for indoor installation.~~
- ~~j. As a minimum, the VFD shall be provided with the following door mounted operator devices:
 - 1. Circuit Breaker operating handle.
 - 2. Hand/Off/Auto
 - 3. VFD Run, VFD Fault, and Power On pilot lights
 - 4. VFD Fault reset pushbutton
 - 5. Motor temperature high pilot light
 - 5. Motor temperature fault reset pushbutton~~

- 6. ~~Door mounted keypad.~~
 - 7. ~~Door mounted speed pot.~~
 - 8. ~~Engraved Nameplate.~~
 - k. ~~VFD shall include a front mounted, sealed keypad operator, with a digital display, to provide complete programming, operating, monitoring, and diagnostic capability. Keys provided shall include commands for RUN, STOP, and RESET. Operating mode (auto or manual) and speed setting functions shall also be provided.~~
 - l. ~~A three line 16 character LCD display shall provide readouts of; output frequency in hertz, output voltage in volts, output current in amps, output power in kilowatts, DC bus voltage in volts, interface terminal status, and fault codes. All displays shall be labeled in easy to read English language. Codes are not acceptable.~~
 - m. ~~Control circuits shall be isolated from power circuits. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door mounted manual speed potentiometer or micro processor type keypad with unit in local mode. The input 4-20 mA signal to be optically isolated from the drive run control circuit.~~
 - n. ~~VFD shall be capable of full rated output when powered by incoming voltage with Total harmonic Distortion (THD) in excess of 10%.~~
 - o. ~~Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders~~
 - p. ~~Properly size NEMA 12 aluminum powder coated enclosure to dissipate heat generated by VFD within limits of specified service conditions. Circuit breaker interlock to be able to be bypassed via lever on front door surface. Provide visual alarm indicator on cabinet door.~~
2. ~~Performance characteristics:~~
- a. ~~Output amps: 110 percent of motor rated full load amps, continuous.~~
 - b. ~~Acceleration time to top speed, 1-300 seconds, minimum, adjustable.~~
 - c. ~~Deceleration time from top speed, 1-300 seconds, minimum, adjustable.~~
 - d. ~~Frequency stability: $\pm 0.5\%$ (at 25 degrees C, ± 10 degrees C) after reaching operating temperature.~~

- e. ~~Output voltage: Proportional to frequency with low speed boost.~~
 - f. ~~VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.~~
 - g. ~~The VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.~~
3. ~~Drive Protection:~~
- a. ~~General:~~
 - (1) ~~Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature. The VFD shall employ three (3) current limit circuits to provide trip free operation. The slow current regulation limit circuit shall be adjustable from 30% to 100% of the VFD's variable torque current rating. The rapid current regulation limit shall be 120% of the VFD's variable torque current rating. The current switch off limit shall be fixed at a minimum 150% of the VFD's variable torque current rating.~~
 - b. ~~Internal Protection: Minimum circuitry as follows:~~
 - (1) ~~Current limiting, fast acting, DC bus semiconductor fuse for protection of internal power semiconductors.~~
 - (2) ~~Instantaneous output overcurrent trip max. 150 percent.~~
 - (3) ~~Grounded control chassis.~~
 - (4) ~~Under and over voltage trip, 3 phases.~~
 - (5) ~~Internal motor overload protection, with internal speed sensing UL recognized protection.~~
 - (6) ~~VFD heat sink over temperature.~~
 - e. ~~Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. One isolated Form C contact and two programmable Form A contacts shall be provided for remote indication of alarms to include the following:~~
 - (1) ~~Over/under voltage indication.~~

- (2) ~~Overcurrent trip indication.~~
 - (3) ~~Over temperature alarm or trip.~~
 - (4) ~~Fault detection indication.~~
 - (5) ~~Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed).~~
- d. ~~Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting for a minimum of 2 seconds.~~
 - e. ~~Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.~~
- C. ~~Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions.~~
- 1. ~~Provide integral fans or cooling systems.~~
 - 2. ~~LOCAL/REMOTE selection of Speed Control.~~
 - 3. ~~Circuit breaker interlock to be able to be able to be bypassed via lever on front door surface.~~
 - 4. ~~NEMA 12 type aluminum powder coated enclosures to have keypad controls located on exterior of enclosure.~~
 - 5. ~~Provide visual alarm indicators and reset pushbuttons on cabinet door.~~
 - 6. ~~Fans shall be located to allow quick removal and replacement without disassembly of drive components.~~
- D. ~~Minimum Control Features:~~
- 1. ~~LOCAL/REMOTE selection of Start/Stop control.~~
 - 2. ~~LOCAL/REMOTE selection of Speed Control.~~
 - 3. ~~Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.~~

4. ~~Provide a 4-20 mA output signal proportional to VFD output frequency for remote speed indication.~~
5. ~~Provide isolated contact signal for Remote Ready—indication of in remote and power available.~~
6. ~~Provide isolated contact signal for VFD/motor running.~~
7. ~~Provide isolated contact signal for Motor Temperature High fault.~~
8. ~~Provide isolated contact signal for VFD fault.~~
9. ~~Provide isolated contact signal for Valve Open~~
10. ~~Provide isolated contact signal for Emergency Stop.~~
11. ~~Accept VFD fault reset signal.~~

~~E. Devices:~~

1. ~~Provide operating, monitoring or alarm indicating devices, door mounted, with minimum as follows:~~
 - a. ~~Drive System Disconnect Operator—Circuit breaker with 65KA short circuit rating and adjustable trip unit.~~
 - b. ~~System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run).~~
 - c. ~~System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer).~~
 - d. ~~Manual speed potentiometer or keypad controls to set speed in manual mode.~~
 - e. ~~Speed indicating meter in percent speed to indicate speed of the converter powered motor.~~
 - f. ~~Alarm and status lights. Provide LED cluster type.~~

~~F. Components and the full assembled protected chassis shall be tested in accordance with the manufacturer's standard factory testing program.~~

~~G. Every VFD shall be powered and connected to a motor for a full functional test and manual inspection.~~

~~2.04 SPARE PARTS:~~

~~A. Provide the following spare parts in accordance with Section 01730:~~

- ~~1. One of each printed circuit board~~
- ~~2. One of each DC bus fuse~~
- ~~3. One of each pre-charge contactor~~
- ~~4. One set of heat sink fans~~
- ~~5. One internal fan.~~

2.05 Auxiliary Equipment

~~A. Provision for the following equipment shall be included in the VFD enclosure:~~

~~a. Temperature monitoring and alarm system for the motor RTD's specified in Section 01171. Requirements for RTD's and monitoring system follow below:~~

~~b. Resistance Temperature Detector (RTD) monitor system:~~

- ~~i. Platinum, 100 ohm RTD's embedded in the motor windings for each phase and in each bearing of both the motor and pump.~~
- ~~ii. Continuously monitor the temperature of the three wire bearing RTD's.~~
- ~~iii. Include a display and switch to permit monitoring of actual bearing temperature.~~
- ~~iv. Provide an adjustable alarm feature to select an alarm temperature. Selection of temperature range by pump manufacturer. Alarm when bearings reach the selected temperature.~~
- ~~v. Provide an alarm light until reset, and a set of contacts, rated not less than 5 amps at 120 VAC.~~
- ~~vi. Temperature range as recommended by the pump manufacturer.~~
- ~~vii. Trip point repeatability of not more than 1.8 deg. F. detection circuit response time of 5 milliseconds, maximum; deadband, 2 percent maximum; calibration accuracy of 1 deg. F.~~

~~c. Control circuits for the pump and pump control valve, as shown in Section 01172A.~~

PART 3 – INSTALLATION

3.01 INSPECTION:

A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.

~~B. Visually inspect delivered unit(s) for conformance with specification.~~

~~C. Verify availability of appropriate pacing signal.~~

3.02 INSTALLATION:

A. Factory-trained service personnel shall inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes.

B. The VFD's shall be installed in accordance with the manufacturer's installation instructions, and approved shop drawings

3.03 FIELD TESTING:

A. Manufacturer's service engineer is to perform testing checkout, and start-up for variable frequency drive equipment.

~~B. Field Tests:~~

~~1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:~~

~~a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.~~

~~b. Output to the driven load in kilowatts.~~

~~c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the immediate upstream protective device for maximum and minimum load conditions.~~

~~d. Measure the total harmonic voltage distortion and total harmonic current distortion at the load side terminals of the service entrance protective device for maximum and minimum load conditions.~~

~~2. Test each drive by using the actual control signal for remote and local operation.~~

~~3. Test each driver's alarm functions.~~

~~4. Perform all tests in the presence of the Owner's representative.~~

~~5. Perform the above test in addition to the manufacturer's normal field tests.~~

6. ~~Submit final test report.~~

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This Section specifies the general methods and requirements of submissions applicable to the following work-related submittals.
 - 1. Shop Drawings, Product Data and Samples.
 - 2. Mock Ups.
 - 3. Construction Photographs.
 - 4. Contractor's Responsibilities.
 - 5. Submission Requirements.
 - 6. Review of Shop Drawings, Product Data, Working Drawings and Samples.
 - 7. Distribution.
 - 8. General Procedures for Submittals.
 - 9. Certificate of Design.
 - 10. Certificates of Compliance.
 - 11. Schedules.
- B. Additional general submission requirements are contained in Paragraph 6.17 of the General Conditions.
- C. Detailed submittal requirements will be specified in the technical specifications section.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES:

- A. Shop Drawings:
 - 1. Shop drawings, as defined in the General Conditions, and as specified in individual work Sections include, but are not necessarily limited to: custom-prepared data such as fabrication and erection/installation (working) drawings of concrete reinforcement, structural details and piping layout, scheduled information, setting diagrams, actual

shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications as applicable to the work.

2. All shop drawings shall be submitted using the transmittal form furnished by the Engineer.
3. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
4. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the Drawings and Specifications. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
5. All details on shop drawings submitted for approval shall show clearly the relation of the various parts of the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted for approval.

B. Product Data:

1. Product data as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and printed installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances including certificates of compliance and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

C. Samples:

1. Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the Work.

1.03 MOCK UPS:

- A. Mock Up units as specified in individual Sections, include but are not necessarily limited to, complete units of the standard of acceptance for that type of work to be used on the project. Remove at the completion of the work or when directed by the Engineer.

1.04 CONSTRUCTION PHOTOGRAPHS:

- A. The Contractor shall provide construction photographs in accordance with requirements specified in Section 01380.

1.05 CONTRACTOR'S RESPONSIBILITIES:

- A. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Catalog numbers and similar data
 - 4. Conformance with the Specifications
- B. Each shop drawing, sample, and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets 11-in. X 17-in. and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Engineer a copy of each submittal transmittal form for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples to the Engineer.
- C. If a shop drawing shows any deviation from the requirements of the Contract Documents, the Contractor shall make specific mention of the deviations in the Transmittal Form furnished by the Engineer and provide a description of the deviations in a letter attached to the submittal.
- D. The review and approval of shop drawings, samples or product data by the Engineer shall not relieve the Contractor from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will not have responsibility therefor.
- E. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of

such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

F. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

1. Manufacturer's printed installation instructions, a part of product data submitted to the Engineer will not be reviewed and are for informational purposes only.

1.06 SUBMISSION REQUIREMENTS:

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. All submittals shall be submitted sufficiently in advance of construction requirements to provide no less than fourteen working days, excluding Saturdays, Sundays and legal holidays for review from the time received at the Engineer's reviewing office. For submittals of major equipment, that require more than fourteen days to review, due to its sheer complexity and amount of detail and also requiring review by more than one engineering discipline, a letter will be sent by the Project Manager or his/her designee to the Contractor informing him/her of the circumstances and the date it is expected the submittal will be returned to the Contractor.

C. Number of submittals required:

1. Shop Drawings: Unless otherwise stated in the respective Specifications Sections, submit six (6) copies.
2. Product Data: Unless otherwise stated in the respective Specifications submit six (6) copies.
3. Samples: Submit the number stated in the respective Specification Sections.

D. Submittals shall contain:

1. The date of submission and the dates of any previous submissions.
2. The Project title and number.
3. Contractor identification.
4. The names of:
 - a. Contractor

b. Supplier

c. Manufacturer

5. Identification of the product, with the specification section number, page and paragraph(s).

6. Field dimensions, clearly identified as such.

7. Relation to adjacent or critical features of the Work or materials.

8. Applicable standards, such as ASTM or Federal Specification numbers.

9. Identification of deviations from Contract Documents.

10. Identification of revisions on resubmittals.

11. An 8-in. X 3-in. blank space for Contractor and Engineer stamps.

E. Each shipment of drawings shall be accompanied by a transmittal form furnished by the Engineer providing a list of the drawing numbers and the names mentioned above.

F. Submittals shall be separated by specification section. Do not combine submittals for different specification sections under the same transmittal.

1.07 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES:

A. The Engineer's review is for general conformance with the design concept and contract drawings. Markings or comments shall not be construed as relieving the Contractor from compliance with the contract plans and specifications or from departures therefrom. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

B. The review of shop drawings, data, and samples will be general. They shall not be construed:

1. as permitting any departure from the Contract requirements;

2. as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;

3. as approving departures from details furnished by the Engineer, except as otherwise provided herein.

- C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.
- D. Two (maximum) copies of shop drawings or product data will be returned to the Contractor via First Class United States Postal Service. Samples will not be returned.
- E. Submittals will be returned to the Contractor under one of the action codes indicated and defined on the transmittal form furnished by the Engineer.
- F. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing, on the letter of transmittal and on resubmitted shop drawings by use of revision triangles or other similar methods, to revisions other than the corrections requested by the Engineer, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the Engineer.
- G. Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor, and will be considered "Rejected" until resubmitted. The Engineer may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.
- H. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least seven working days prior to release for manufacture.
- I. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

1.08 DISTRIBUTION:

- A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer but shall not exceed 6.

1.09 GENERAL PROCEDURES FOR SUBMITTALS:

- A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections, of the Specifications, so that the installation will not be delayed by processing times including disapproval resubmittal (if required), coordination with other submittals, inspection, testing (off-site and on-site), purchasing, fabrication, delivery and

similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

Engineer shall receive no less than 21 calendar days from date of receipt to return shop drawings. Requests for Information (RFIs) are no less than 7 calendar days from date of receipt to return RFI response.

1.10 CERTIFICATE OF DESIGN:

- A. If specifically specified in other Sections of these Specifications, the Contractor shall submit the applicable Certificate of Design for each item required, and in the form attached to this Section, completely filled in and signed and sealed by a registered professional engineer.

1.11 CERTIFICATES OF COMPLIANCE:

- A. Certificates of Compliance as specified in the specifications shall include and mean certificates, manufacturer's certificates, certifications, certified copies, letters of certification and certificate of materials.
- B. The Contractor shall be responsible for providing Certificates of Compliance as specified in the technical specifications. Certificates are required for demonstrating proof of compliance with specification requirements and shall be executed in 6 copies unless otherwise specified. Each certificate shall be signed by an official authorized to certify on behalf of the manufacturing company and shall contain the name and address of the Supplier, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies. Certification shall not be construed as relieving the Supplier from furnishing satisfactory material, if after tests are performed on selected samples, the material is found not to meet the specific requirements.

END OF SECTION

CERTIFICATE OF DESIGN

The undersigned hereby certifies that he/she is a Professional Engineer registered in the state of _____ and that he/she has been employed by (Name of Contractor) _____ to design _____ in accordance with Specifications Section _____ for the (Name of Project) _____. The undersigned further certifies that he/she has performed similar designs previously and has performed the design of the _____; that said design is in conformance with all applicable local, state, and federal codes, rules, and regulations and professional practice standards; that his/her signature and Professional Engineer (P.E.) Stamp have been affixed to all calculations and drawings used in, and resulting from, the design; and that the use of that stamp signifies the responsibility of the undersigned for that design.

The undersigned hereby certifies that he/she has Professional Liability Insurance with limits of \$1,000,000.00 and a Certificate of Insurance is attached.

The undersigned hereby agrees to make all original design drawings and calculations available to the Town/City of _____ or Owner's representative within seven (7) days following written request therefore by the Owner.

_____ P.E. Name	_____ Contractor's Name
_____ Signature	_____ Signature
_____ Title	_____ Title
_____ Address	_____ Address

SECTION 01310

CONSTRUCTION PROGRESS SCHEDULES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. CONTRACTOR shall prepare and submit to ENGINEER for review within 60 days after Notice to Proceed, a construction progress schedule.
- B. No work shall be done between 6:00 p.m. and 8:00 a.m. nor on Sundays or legal holidays without written permission of OWNER. However, emergency work may be done without prior permission.
- C. Night work may be established by CONTRACTOR as regular procedure with written permission of OWNER. Such permission, however, may be revoked at any time by OWNER if CONTRACTOR fails to maintain adequate equipment and supervision for proper prosecution and control of work at night.

1.02 FORM OF SCHEDULES:

- A. Prepare schedules in form of a horizontal bar chart.

Provide separate horizontal bar for each trade or operation.

Horizontal Time Scale: Identify first work day of each week.

Scale and spacing to allow space for notations and future revisions.

- B. Format of Listings: Chronological order of start of each item of work.
- C. Identification of Listings: By major specification section numbers.

1.03 CONTENT OF SCHEDULES:

- A. Construction Progress Schedule:

Show complete sequence of construction by activity.

Show dates for beginning and completion of each major element of construction and installation dates for major items of equipment. Elements shall include, but not be limited to, the following:

Shop drawing receipt from supplier/manufacture submitted to ENGINEER, review and return to supplier/manufacture.

Material and equipment order, manufacturer, delivery, installation, and checkout.

Performance tests and supervisory services activity.

Piping, duct work, and wiring installation.

Construction of various facilities.

Concrete pour sequence.

Structural steel erection.

Precast concrete erection.

Backfilling, grading, seeding, sodding, landscaping, fence construction, and paving.

Electrical work activity.

Heating, ventilating, and air conditioning work activity.

Plumbing work activity.

Sewer installation.

Connection to existing sewers.

Water main installation.

Subcontractor's items of work.

Final cleanup.

Allowance for inclement weather.

Demolition.

Miscellaneous concrete placement.

Show projected percentage of completion for each item as of first day of each month.

1.04 SCHEDULE REVISIONS:

- A. Every 14 days CONTRACTOR shall revise construction schedule to reflect changes in progress of work.

- B. Indicate progress of each activity at date of submittal.
- C. Show changes occurring since previous submittal of schedule.

Major changes in scope.

Activities modified since previous submittal.

Revised projections of progress and completion.

Other identifiable changes.

- D. Provide a narrative report as needed to define:

Problem areas, anticipated delays, and impact on schedule.

Corrective action recommended and its effect.

Effect of changes on schedules of other CONTRACTORS.

1.05 SUBMITTAL REQUIREMENTS:

- A. For initial submittal of construction schedule and subsequent revisions thereof, furnish six copies of schedule to ENGINEER.

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide construction photographs pertinent to the Contract work during the Contract period as specified and as directed by the Engineer.
- B. Requirements herein may be waived at the Engineer's discretion.

1.02 SUBMITTALS:

- A. Proposed Photographer:
 - 1. Several different samples of work by proposed photographer on construction photography of similar nature to the work under this Contract.
 - 2. Two copies of proposed photographer's experience and qualifications in similar work. Include copies of references and any certification acquired.
 - 3. Two copies of techniques, materials and equipment proposed to be used.
- B. Two copies of each print, each identified and mounted as specified.
- C. Compact Discs (CD-R) with digital version of photos.

1.03 QUALITY ASSURANCE:

- A. Photographer proposed to be approved by Engineer.
- B. Photographer's experience and qualifications:
 - 1. Not less than 2 accumulated years of experience with similar construction photography.
- C. Photographer to use techniques, material and equipment capable of producing photographs of high quality and resolution.
- D. Photographer to be available on call on one day notice when requested by Engineer and be prepared to respond on shorter notice in unusual or unexpected conditions.

- E. Dates for photography at site to be coordinated with Engineer and Engineer to be present during photographic periods at site unless approved otherwise by Engineer.
- F. Photographer to make and retain detailed records of all photographs by photographer under this Contract:
 - 1. The records to be in sufficient detail to support any attestation that may be required of photographer.
 - 2. Photographer to retain such records for a period not less than two years from the final acceptance of entire work under this Contract.

PART 2 - PRODUCTS

2.01 DIGITAL CAMERA:

- A. Digital camera shall be of at least 8.0 megapixel resolution.

2.02 PRINTS:

- A. Type: Color prints from digital pictures and copies on compact disc (CD-R) at full resolution for print size specified.
- B. Finish: Smooth glossy surface.
- C. Size: 8-in. x 10-in. plus suitable margin for identification.
- A. Paper weight: Single weight.
- B. Number of prints: Two of each photograph.

2.03 PRINT IDENTIFICATION:

- A. Each print to carry identification and information on it in a manner that results in minimum interference with exposure printed.
- B. Front of Print:
 - 1. Top margin:
 - a. Project name.
 - b. Brief title of view.
 - 2. Bottom margin:

- a. Photographer's numbered identification of exposure.
- b. Time and date of exposure.
- c. Name of photographer making exposure.

C. Back of Print:

1. Detailed description of view including point from which exposure made, compass direction of view, vertical declination of view (horizontal, looking up, looking down etc.) identification of main features in view and any other data and information pertinent to the purpose and identification of the exposure photographer feels necessary to include.
2. Weather conditions under which exposure made.

2.04 PRINT MOUNTING:

A. Each print to be inserted in a clear plastic envelope design for the purpose:

1. Print deterioration not to be caused by envelope material or fabrication.
2. Designed to prevent print from accidentally slipping out of envelope.
3. Front and back of print to be visible through the plastic envelope.
4. Permit convenient removal and insertion of print.
5. To have 1-in. hinged binding edge suitable for approved binder specified under subsection PRINT FILING BINDER.

2.05 PRINT FILING BINDER:

A. Furnish Engineer suitable approved binders for filing specified under subsection PRINT MOUNTING.

1. Initially furnish 2 binders and subsequently such additional binders as required by Engineer for filing the prints.
2. All binders to be alike unless otherwise approved by Engineer.

B. Binders:

1. Sturdy and durable for long term filing of prints.
2. Provisions for labeling front cover and binding face.

3. Have sturdy durable back and front cover hinges.
4. Of size suitable for filing mounted prints.
5. Permit convenient removal and insertion of mounted prints.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. Contractor notify Engineer at least 5 days in advance of any photographic sessions.
- B. Photographer to furnish additional prints beyond the number specified when request by Engineer at commercial rates applicable at time of purchase.
- C. All views to contain a relative dimension reference that is easily recognizable by the average person. In views where dimensions are critical use a recognizable measuring devices such as folding ruler, measuring tape in a manner the markings are clear and sharp in the photograph and the device located in close relationship with subject of photograph.

3.02 SITE PHOTOGRAPHY REQUIRED:

- A. Provide photographs at following stages of construction:
 1. Site before commencement of any construction.
 2. Site upon completion of site clearing.
 3. At completion of each structural excavation.
 4. At completion of each structural foundation.
 5. At completion of framing or forming for structures.
 6. At completion of enclosures of structures.
 7. At 1-month intervals, progress photography during construction of facilities. Photos of any month need show only new work performed during month.
 8. Such special photographs required by Engineer.
 9. Upon completion of all Contract work over-all site photography.

B. Views:

1. Coordinate with Engineer on views to be taken. In general views from locations to adequately illustrate state of project and condition of construction.
2. At least 3 different views of photographic subject except over-all site photography to have at least 4 different views unless otherwise approved by Engineer.
3. Succeeding photography of same photographic subject to be taken, insofar as practical, from the same view points as preceding photographic sessions. Variations in this procedure to be approved by Engineer.

3.03 ROUTE PHOTOGRAPHY REQUIRED:

A. Provide progressive photographs of route before commencement of construction:

1. Progressive photographs of route starting at one end of route and progressing to other end then reverse progressive photography back to point of beginning.
2. Each exposure to overlap preceding exposure by 1/4 to 1/3 of the frame.
3. Additional photographs of features along route as directed by Engineer.

B. In the portions of the route where clearing is required make an additional set of progress photographs in similar manner specified for the initial route photography after all clearing work completed and before any other work commences in the cleared portion of the route.

C. During Construction:

1. At least once per week to illustrate state of project, condition of construction and progress in the previous week. Work photographed in previous sessions only photographed again sufficiently to provide progressive continuity of work unless otherwise directed by Engineer.
2. Such special photographs required by Engineer.

D. Upon Completion of All Construction Work:

1. Progressive photographs of route in same manner as that specified before commencement of Contract Work.
2. The route may be photographed in increments when work in that increment is completed and when approved by Engineer. Each increment photography to overlap other increment photography sufficiently such that all photographs provide progressive views of the route throughout.

END OF SECTION

SECTION 01400

QUALITY ASSURANCE

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section covers Quality Assurance and Control requirements for this contract.
- B. The Contractor is responsible for controlling the quality of work, including work of its subcontractors, and suppliers and for assuring the quality specified in the Technical Specifications is achieved.

1.02 CONTRACTOR FURNISHED TESTING LABORATORY SERVICES:

- A. An independent commercial testing laboratory acceptable to the Engineer shall perform all tests that require the services of a laboratory to determine compliance with the Contract Documents. The laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards.
- B. Preliminary Testing Services: The Contractor shall be responsible for all testing laboratory services in connection with concrete materials and mix designs, the design of asphalt mixtures, gradation tests for structural and embankment fills, backfill materials, and all other tests and engineering data required for the Engineer's review of materials and equipment proposed to be used in the Work. The Contractor shall obtain the Engineer's acceptance of the testing laboratory before having services performed, and shall pay all costs for services.
- C. The Contractor shall not retain any testing laboratory against which the Owner or the Engineer have reasonable objection, and if at any time during the construction process the services become unacceptable to the Owner, or the Engineer, either the Owner or the Engineer may direct in writing that such services be terminated. The request must be supported with evidence of improper testing or unreasonable delay. If the Engineer determines that sufficient cause exists, the Contractor shall terminate the services and engage a different testing laboratory.
- D. Transmittal of Test Reports: Written reports of testing and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.
- E. The Contractor's testing laboratory shall furnish four copies of a written report of each test performed by laboratory personnel within three days after each test is completed. Distribution shall be two copies of each test report to the Engineer's Representative, one

copy to the Owner, and one copy for the Contractor.

1.03 OWNER FURNISHED TESTING AND INSPECTION SERVICES:

- A. The Contractor shall furnish a construction schedule and a minimum of 48 hour notice of readiness for testing and inspection of the work. The Engineer shall determine the exact time and location of field sampling and testing, and may require such additional sampling and testing as necessary to determine that materials and equipment conform with data previously furnished by Contractor and with the Contract Documents.
- B. The Contractor shall schedule the work to permit adequate time for testing and re-testing should test results not conform to the contract documents. Lack of testing or inspection which is attributable to insufficient notice by the Contractor or failure of the Contractor to cooperate, will be cause for rejection of the work.
- C. The Contractor shall deliver materials in sufficient quantities to the Owner's testing agency as may be required. Laboratory testing shall be performed within a reasonable time, consistent with the specified standards.
- D. The Contractor shall furnish material samples and cooperate in the field sampling and testing activities, interrupting the work when necessary. The Contractor shall furnish personnel, facilities and access to assist in the sampling and testing activities.

1.04 QUALITY ASSURANCE:

- A. Copies of applicable referenced standards are not included in the Contract Documents. Where copies of standards are needed by the Contractor for superintendence and quality control of the work, the Contractor shall obtain a copy or copies directly from the publication source and maintain at the jobsite, available to the Contractor's personnel, subcontractors, and Engineer
- B. Quality of Materials: Unless otherwise specified, all materials and equipment furnished for permanent installation in the Work shall conform to applicable standards and specifications and shall be new, unused, and free from defects and imperfections, when installed or otherwise incorporated in the Work. The Contractor shall not use material and equipment for any purpose other than that intended or specified unless the Engineer authorizes such use.
- C. Where so specified, products or workmanship shall also conform to the additional performance requirements included within the Contract Documents to establish a higher or more stringent standard or quality than that required by the referenced standard.

1.05 OFFSITE INSPECTION:

- A. When the specifications require inspection of materials or equipment during the production, manufacturing, or fabricating process, or before shipment, such services shall

be performed by the Owner's independent testing laboratory, or inspection organization acceptable to Engineer in conjunction with or by the Engineer.

- B. The Contractor shall give appropriate written notice to the Engineer not less than 30 days before offsite inspection services are required, and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to cooperate with inspecting personnel in the performance of their duties.

1.06 MATERIALS AND EQUIPMENT:

- A. The Contractor shall maintain control over procurement sources to ensure that materials and equipment conform to specified requirements in the Contract Documents.
- B. The Contractor shall comply with manufacturer's printed instructions regarding all facets of materials and/or equipment movement, storage, installation, testing, startup, and operation. Should circumstances occur where the contract documents are more stringent than the manufacturer's printed instructions, the Contractor shall comply with the specifications. In cases where the manufacturer's printed instructions are more stringent than the contract documents, the Contractor shall advise the Engineer of the disparity and conform to the manufacturer's printed instructions. In either case, the Contractor is to apply the more stringent specification or recommendation, unless approved otherwise by the Engineer.

1.07 SHOP AND FIELD TESTING:

- A. The Contractor is responsible for providing advance notice of and access for the shop and field testing specified in the technical specification sections.
- B. The Contractor and its Subcontractor shall permit inspections, tests, and other services as required by the Contract Documents.
- C. Contractor shall provide twenty one days written notice to the Engineer so that the Engineer may schedule and witness off site and on site tests. The Engineer's witnessing of tests does not relieve the Contractor and/or Subcontractors of their obligation to comply with the requirements of the Contract Documents.

1.08 MANUFACTURER'S FIELD SERVICES:

- A. When specified in the technical specifications sections, the Contractor shall arrange for and provide technical representation from manufacturer's of respective equipment, items or components. The manufacturer's representative shall be a factory trained service engineer/technician with the type and length of experience specified in the technical specifications.
- B. Services Furnished Under This Contract: An experienced, competent, and authorized factory trained service engineer/technician representative of the manufacturer of each

item of equipment for which field services are indicated in the specifications shall visit the site of the Work and inspect, operate, test, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's service representative shall be present when the equipment is placed in operation. The manufacturer's service representative shall revisit the jobsite as often as necessary until all problems are corrected and the equipment installation and operation are satisfactory to the Engineer.

1.09 CERTIFICATION FORMS AND CERTIFICATES:

- A. The Contractor shall be responsible for submitting the certification forms and certificates in conformance with the requirements specified in Section 01300 - Submittals.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 QUALITY CONTROL:

- A. Quality control is the responsibility of the Contractor, and the Contractor shall maintain control over construction and installation processes to assure compliance with specified requirements.
- B. Certifications for personnel, procedures, and equipment associated with special processes (e.g., welding, cable splicing, instrument calibration, surveying) shall be maintained in the Contractor's field office, available for inspection by the Engineer. Copies shall be made available to the Engineer upon request.
- C. Means and methods of construction and installation processes are the responsibility of the Contractor, and at no time is it the intent of the Engineer to supersede or void that responsibility.

END OF SECTION

SECTION 01500
TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. The Contractor shall provide all temporary facilities for the proper completion of the work, as required and as specified.

1.02 SANITARY REGULATIONS:

- A. The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required.
- B. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the Owner, or on adjacent property.

1.03 WATER SUPPLY:

- A. The Contractor shall make arrangements and pay for all water necessary for completion of construction operations under this contract.
- B. For all necessary operations at the site of the work (except as noted in the next paragraph below) the Owner, without charge therefor, shall provide reasonable quantities of water at the then existing pressure from a mutually convenient hydrant of the water distribution system. The Contractor shall furnish all necessary pipe or hose extensions to conduct the water to the points of use and shall exercise due care not to waste water. The Contractor shall not contaminate the water supply and shall comply with all applicable regulations and code requirements.
- C. The Owner reserves the right to limit, suspend, or terminate the supplying of water as set forth above should it consider such action to be necessary on account of damage to the distribution system, the necessity of conserving water, or other emergency. In this event, the Contractor shall obtain water from some other approved source, at his own expense.

1.04 ELECTRICAL ENERGY:

- A. The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light necessary for the proper completion of the Work and during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, connections, and meters.
- B. The Contractor shall provide sufficient electric lighting so that all work may be done in a workmanlike manner when there is not sufficient daylight.

1.05 PRECAUTIONS DURING ADVERSE WEATHER:

- A. During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means.
- B. During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will take place and a proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means which will result in a moist or a dry atmosphere according to the particular requirements of the work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used.

1.06 CONTRACTOR'S FIELD OFFICE:

- A. The Contractor shall maintain a temporary field office near the work for his own use during the period of construction at which readily accessible copies of all contract documents shall be kept. The office shall be located where it will not interfere with the progress of the work. In charge of this office there shall be a competent superintendent of the Contractor as specified under "Supervision of Work" in the AGREEMENT.

~~1.07 TEMPORARY FENCING:~~

- ~~A. Provide commercial grade chain link fence to prevent trespass by workmen and suppliers onto private property and the public from construction site.~~
- ~~B. Provide 6 foot high fence around construction site. Equip fence with vehicular and pedestrian gates with locks.~~
- ~~C. Coordinate location of temporary fencing with Owner (Engineer).~~

END OF SECTION

SECTION 01568

EROSION CONTROL, SEDIMENTATION AND CONTAINMENT OF CONSTRUCTION MATERIALS

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. Provide all work and take all measures necessary to control soil erosion resulting from construction operations, prevent flow of sediment from construction site, and contain construction materials (including excavation and backfill) within protected working area as to prevent damage to any stream or wetlands.

1.02 REFERENCE:

- A. "Guide-lines for Erosion and Sediment Control, Planning and Implementation" and "Processes, Procedures and Methods to Control Pollution Resulting from all Construction Activity", published by the United States Environmental Protection Agency.
- B. Florida Department of Environmental Protection and City of Marco Island and Collier County guidelines and procedures.

1.03 SUBMITTALS:

- A. Two weeks prior to the start of the work, submit to Engineer, for review, a plan with detailed sketches showing the proposed methods to be used for controlling erosion during construction.

1.04 QUALITY ASSURANCE:

- A. Use acceptable procedures, including use of water diversion structures, diversion ditches, settling basins, and sediment traps.
- B. Operations restricted to areas of work indicated on drawings and area which must be entered for construction of temporary or permanent facilities.
- C. If construction materials are washed away during construction, remove materials from fouled areas.
- D. Stabilize diversion outlets by means acceptable to Engineer.
- E. Engineer has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations and to direct immediate permanent or temporary pollution control measures to prevent contamination of any stream or

wetlands, including construction of temporary berms, dikes, dams, sediment basins, sediment traps, slope drains, and use of temporary mulches, mats, or other control devices or methods as necessary to control erosion.

PART 2 – PRODUCTS

2.01 BALES:

- A. Hay or straw or other suitable material acceptable to Engineer.

2.02 WOOD STAKES:

- A. 2 in. by 2 in. by 3 ft.

PART 3 – EXECUTION

3.01 GENERAL:

- A. Do not discharge chemicals, fuels, lubricants, bitumen, raw sewage and other harmful waste into or alongside any body of water or into natural or man-made channels.

3.02 INSTALLATION:

- A. Install baled hay or straw erosion checks in all locations as directed, surrounding base of all deposits of stored excavated material outside of disturbed area, and where directed by the Engineer.
- B. Install checks immediately after site is cleared and before trench excavation. Locate checks, surrounding stored material, approximately 6 ft. from material.
- C. Hold bales in place with two 2 in. by 2 in. by 3 ft. stakes so that each bale is butted tightly against ad-joining bale thereby precluding shortcircuiting of erosion check.
- D. Construct earth berms or diversions to intercept and divert runoff water from critical areas.
- E. Discharge silt-laden water from excavations onto filter fabric mat and/or baled hay or straw sediment traps to ensure that only sediment-free water is returned to watercourses.
- F. Do not place excavated soil material adjacent to water-course in manner that will cause it to wash away by high water or runoff.
- G. Prevent damage to vegetation by excessive watering or silt accumulation in the discharge area.

- H. Do not dump spoiled material into any streams, wetlands, surface waters, or unspecified locations.
- I. Prevent indiscriminate, arbitrary, or capricious operation of equipment in streams, wetlands or surface waters.
- J. Do not pump silt-laden water from trenches or excavations into surface waters, streams, wetlands, or natural or man-made channels leading thereto.
- K. Prevent damage to vegetation adjacent to or outside of construction area limits.
- L. Do not dispose of trees, brush, debris, paints, chemicals, asphalt products, concrete curing compounds, fuels, lubricants, insecticides, washwater from concrete trucks or hydroseeders, or any other pollutant in streams, wet-lands, surface waters, or natural or man-made channels leading thereto, or unspecified locations.
- M. Do not alter flow line of any stream unless indicated or specified.

END OF SECTION

SECTION 01600

CONTROL OF MATERIALS

PART 1 - GENERAL

1.01 APPROVAL OF MATERIALS:

- A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the work without prior approval of the Engineer.
- B. As specified in Section 01300, the Contractor shall submit to the Engineer, data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.
- C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.
- D. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.
- E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes, and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.
- F. The materials and equipment used on the work shall correspond to the approved samples or other data.

1.02 BOLTS, ANCHOR RODS AND NUTS:

- A. All necessary bolts, anchor rods, nuts, washers, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith. Anchor rods and shall have suitable washers and hexagonal nuts.
- B. All anchor rods, nuts, washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated or specified.

- C. Unless otherwise specified, stud, tap, and machine bolts, and nuts shall conform to the requirements of ASTM Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A325. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to ANSI Standard B1.1 for Unified Inch Screw Threads (UN and UNR Thread Form).
- D. Bolts, anchor rods, nuts, and washers, specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with the ASTM Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, Designation A123, or the ASTM Standard Specifications for Zinc Coating (Hot Dip) on Iron and Steel Hardware, Designation A153, as is appropriate.
- E. Bolts, anchor rods, nuts, and washers specified to be stainless steel shall be Type 304 or Type 316 stainless steel, as indicated.
- F. Anchor rods shall be set accurately. They shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and set in the concrete forms with suitable pipe sleeves, or both. If anchor are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.

1.03 GREASE FITTINGS:

- A. Provide extension fittings and tubing on all grease fittings that are installed in an inaccessible location. The extension is to be located so that equipment can be lubricated from the operating level without the use of ladders, staging or shutting down the equipment. Tubing: 316 stainless steel.

1.04 CONCRETE INSERTS FOR HANGERS:

- A. Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized.

1.05 EQUIPMENT FOUNDATIONS, INSTALLATION AND GROUTING:

- A. The Contractor shall furnish the necessary materials and construct suitable concrete foundations for all equipment installed by him, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.
- B. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.
- C. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 in. for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-metallic, non-shrink grout.
- D. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.
- E. Where such procedure is impracticable, the method of placing grout shall be as approved by the engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner and given a burlap-rubbed finish.

1.06 EQUIPMENT DRIVE GUARDS:

- A. All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

END OF SECTION

SECTION 01610

DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 GENERAL:

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY:

- A. Transport and handle items in accordance with manufacturer's printed instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide equipment and personnel to unload all items delivered to the site.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.

1.03 STORAGE AND PROTECTION:

- A. Store and protect products and equipment in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces

of equipment.

- B. Arrange storage of products and equipment to permit access for inspection. Periodically inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
- C. Provide protective maintenance during storage consisting of manually exercising equipment, inspecting mechanical surfaces for signs or corrosion or other damage, lubricating, applying any coatings as recommended by the equipment manufacturer necessary for its protection and all other precautions to assure proper protection of all equipment stored and for compliance with manufacturers' requirements related to warranties.
- D. Store loose granular materials on solid flat surface in a well-drained area. Prevent mixing with foreign matter.
- E. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulation of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in manner to reduce breakage, cracking and spalling to a minimum.
- F. All mechanical and electrical equipment and instruments shall be covered with canvas and stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it shall be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer and to prevent condensation on the equipment being stored.
 - 1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.
 - 2. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding".
 - 3. Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
 - 4. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.

5. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

PART II (not used)

PART III (not used)

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:
 - 1. Closeout procedures.
 - 2. Final cleaning.
 - 3. Adjusting.

1.02 CLOSEOUT PROCEDURES:

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payment, and sum remaining due.

1.03 FINAL CLEANING:

- A. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean.
 - 3. The installing Subcontractor shall wipe surface of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 - 4. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas broom clean; remove stains, spills and

other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even-textured surface.

1.04 ADJUSTING:

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

END OF SECTION

SECTION 01710

CLEANING UP

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. During its progress, the work and the adjacent areas affected thereby shall be cleaned up and all rubbish, surplus materials, and unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.
- B. Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.
- C. On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.
- D. The Contractor shall thoroughly clean all materials and equipment installed by him and his sub-contractors, and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.
- E. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, walk, and landscaping work. Suitable materials, equipment, and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the contract period.

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.
- B. O&M data submittal does not include the pumps, motors, or VFDs.

1.02 RELATED WORK:

- A. Section 01300: Submittals
- B. Section 01400: Quality Assurance
- C. Section 01740: Warranties and Bonds

1.03 OPERATING AND MAINTENANCE INSTRUCTIONS AND PARTS LISTS:

- A. Where reference is made in the Detail Technical Specifications to operating and maintenance instructions and spare parts lists, the Contractor shall furnish for each piece of equipment six complete sets giving the information listed below.
 - 1. The manual for each piece of equipment shall be a separate document with the following specific requirements:
 - a. Contents:
 - (1) Table of contents and index
 - (2) Brief description of each system and components
 - (3) Starting and stopping procedures
 - (4) Special operating instructions
 - (5) Routine maintenance procedures
 - (6) Clean and concise manufacturer's printed operating and maintenance instructions, adjustment, lubrication and other maintenance of equipment including: parts list, illustrations, and diagrams

- (7) One copy of each wiring diagram
- (8) One copy of each approved shop drawing and each Contractor's coordination and layout drawing
- (9) List of spare parts, manufacturer's price, and recommended quantity
- (10) Name, address, and telephone numbers of local service representatives

b. Material:

- (1) Loose leaf on 60 pound, punched paper
- (2) Holes reinforced with plastic cloth or metal
- (3) Page size, 8-1/2-in. by 11-in.
- (4) Diagrams, illustrations, and attached foldouts as required of original quality, reproduced by dry copy method
- (5) Covers: oil, moisture, and wear resistant 9 X 12 size

c. Submittals to the Engineer:

- (1) Three preliminary copies of manuals shall be submitted to the Office of the Consulting Engineer, **AECOM**, 13450 W. Sunrise Blvd. Suite 200, Sunrise, FL 33323, Attention: Jim Penkosky within 14 days after equipment delivery. Provide six final copies of complete manuals prior to testing/startup.

- B. Such instructions and parts lists shall be completely and neatly annotated so that only the specific equipment and features furnished are clearly indicated. References to other sizes and types or models of similar equipment shall be deleted or neatly lined out.
- C. Such instructions and parts lists shall be delivered to the Engineer at the same time that the equipment to which they pertain is delivered to the site. Each submittal shall be accompanied by a transmittal form identifying the information included. Each submittal shall be reviewed by the Engineer for compliance with the above requirements.
- D. If a submittal is acceptable, all three preliminary copies will be retained by the Engineer and three additional copies shall be provided to the Engineer by the Contractor. If deficiencies are found, one copy will be retained by the Engineer and two copies with the deficiencies, noted, will be returned to the Contractor. The copy retained by the Engineer shall not count toward the six complete acceptable sets required herein.

- E. At the Engineer's discretion, he may retain all four copies and request only supplemental information from the Contractor.

1.04 CONTENTS, EACH VOLUME:

- A. Table of Contents: Provide title of Project, names, addresses, and telephone numbers of Engineer, subconsultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- B. For Each Product or System: List names, addresses and telephone number of Subcontractors and suppliers; including local source of supplies and replacement parts.
- C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- D. A list of all parts for the equipment with each part identified by a functional name, the part manufacturer's name and a unique part number, (normally the part manufacturer's alpha-numeric designation). A list of parts keyed by non-unique item numbers to a sectional drawing will not be adequate to fulfill this requirement.
- E. All components of each system, e.g., pump motor, coupling, and drive, shall be combined in a single submittal with the above data provided for each component.
- F. Drawings: Supplement product data to illustrate relations of component parts, and data applicable to installation. Delete inapplicable information.
- G. Type Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's printed instructions specified.
- H. Warranties and Bonds are as specified in Section 01740.

1.05 MANUAL FOR MATERIALS AND FINISHES:

- A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include manufacturer's printed recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Include product data listing, applicable reference standards, chemical composition, and details of installation. Provide printed recommendations for inspections, maintenance, and repair.

- D. Additional Requirements: As specified in individual product specification sections.
- E. Provide a listing in Table of Contents for design data, if provided by Contractor, with tabbed fly sheet and space for insertion of data.

1.06 MANUAL FOR EQUIPMENT AND SYSTEMS:

- A. For each Item of Equipment and Each System provide the following:
 - 1. Description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include certified performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - 2. Panelboard Circuit Directories including electrical service characteristics, controls and communications, and color coded wiring diagrams as installed.
 - 3. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences; regulation, control, stopping, shut-down, and emergency instructions; and summer, winter, and any special operating instructions.
 - 4. Maintenance Requirements:
 - a. Route procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - b. Servicing and lubrication schedule, with list of lubricant type, frequency and method of lubrication. Any components which do not require lubrication or any expendable components which are not normally serviced shall be clearly noted as such.
 - c. Manufacturer's printed operation and maintenance instructions.
 - d. Sequence of operation by controls manufacturer.
 - e. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - f. Lubrication and maintenance schedules shall be similar to that specified in Section 01300.
 - 5. Control diagrams by controls manufacturer as installed.
 - 6. Contractor's coordination drawings, with color coded piping diagrams as installed.

7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 8. List of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
 9. Test and balancing reports as specified.
 10. Additional Requirements: As specified in individual product specification section.
- B. Provide a listing in Table of Contents for design data, if provided by Contractor, with tabbed fly sheet and space for insertion of data.

1.07 INSTRUCTION OF OWNER PERSONNEL:

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times. Where specified in technical Specification Sections for specific equipment or systems, the Contractor shall have instructions video taped while they are being given to Owner's personnel. Video taping shall be performed by a person or organization experienced in the production of tapes and shall include the entire instruction session(s) and all questions and answers. Tapes shall become the property of the Owner.
- B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Prepare and insert additional data in Operations and Maintenance Manual when need for such data becomes apparent during instruction.
- D. Provide a completed and filled-out Equipment Manufacturer's Certificate of Installation, Testing and Instruction form attached to the end of this section.

1.08 SERVICES OF MANUFACTURER'S REPRESENTATIVE:

- A. The Contractor shall arrange for a qualified service representative from each company manufacturing or supplying the equipment required in the specifications.
- B. After installation of the listed equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the representative shall inspect, operate, test, and adjust the equipment. The inspection shall include but shall not be limited to, the following points as applicable:
 - 1. Soundness (without cracked or otherwise damaged parts).
 - 2. Completeness in all details, as specified.
 - 3. Correctness of setting, alignment, and relative arrangement of various parts.
 - 4. Adequacy and correctness of packing, sealing, and lubricants.
- C. The operation, testing, and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.
- D. On completion of his work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a Certificate of Compliance stating that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.
- E. After the Engineer has reviewed the reports from the manufacturers' representatives, the Contractor shall make arrangements to have the manufacturers' representatives present when the field acceptance tests are made.
- F. Refer and conform to the additional requirements specified in Section 01400.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION,
TESTING AND INSTRUCTION

Owner - _____
(fill in)

Project - _____
(fill in description)

Contract No. _____
(fill in)

M&E No. _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

installed for the subject project (has) (have) been installed in a satisfactory manner, (has) (have) been satisfactorily tested, (is) (are) ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date: _____ Time: _____

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

(I) (We) the undersigned, authorized representatives of the _____
and/or Plant Operating Personnel have received classroom and hands-on instruction on the
operation, lubrication, and maintenance of the subject equipment and (am) (are) prepared to
assume normal operational responsibility for the equipment:

_____ Date: _____

_____ Date: _____

_____ Date: _____

SECTION 01740

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties.
- B. Pumps, motors, and VFDs warranties and bonds will be furnished by others via the Owner.

1.02 RELATED WORK:

- A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.
- B. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of Division 2 through 16.
- C. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

1.03 SUBMITTALS:

- A. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within fifteen days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Engineer for approval prior to final execution.

- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.
- E. At Final Completion, compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- F. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-in. by 11-in. paper.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification Section in which specified, and the name of the product or work item.
- H. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer, supplier, and manufacturer.
- I. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name, address, and telephone numbers of the Contractor and equipment supplier.
- J. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.
- K. Schedule of Special Warranties

None

1.04 WARRANTY REQUIREMENT:

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of

Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

- A. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights or remedies.
- B. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- C. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- D. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.05 DEFINITION:

- A. Standard Product Warranties are pre-printed written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 02050

DEMOLITION AND ALTERATIONS

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. Demolish and alter existing facilities as indicated on drawings, as specified, and as directed by Engineer.
- B. Remove, salvage, or otherwise dispose of minor site improvements as specified in Section 02100.

1.02 RELATED WORK:

- A. Section 02100: Site Preparation
- B. Section 02210: Earth Excavation, Backfill, Fill and Grading.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01300:
 - 1. Submit to Engineer for review, a demolition plan describing proposed sequence, methods, and equipment for demolition and disposal of each structure.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified.
- B. Demolish and remove existing construction, utilities, equipment, and appurtenances without damaging integrity of existing structures, equipment, and appurtenances that are to remain.
- C. Store equipment to be salvaged for relocation where directed by Engineer, and if necessary, protect from damage during work.
- D. Repair or remove items that are damaged. Repair and install damaged items at no additional compensation and to condition at least equal to that which existed prior to start of work.
- E. Exercise all necessary precautions for fire prevention. Make acceptable fire extinguishers available at all times in areas where demolition work by burning torches is being done.

Do not burn demolition debris on or near site.

- F. Protect persons and property throughout progress of work. Proceed in such manner as to minimize spread of dust and flying particles and to provide safe working conditions for personnel.
- G. Maintain circulation of traffic within area at all times during demolition operations.
- H. Obtain permission from Engineer before abandoning or removing any existing structures, materials, equipment and appurtenances.
- I. Make necessary arrangements with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 DEMOLITION:

- A. Provide three reference points for each survey marker and monument removed, established by a licensed civil engineer or land surveyor and record locations and designations of survey markers and monuments prior to removal.
- B. Store removed markers and monuments during demolition work, and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Forward letter to Engineer signed by licensed civil engineer or land surveyor verifying reestablishment of survey markers and monuments.

3.02 DEMOLITION:

- A. Confine apparatus, storage of materials, demolition work, new construction, and operations of workmen to areas that will not interfere with continued use and operation of entire facility. Provide and maintain lights, barriers, and temporary passageways for free and safe access.
- A. Wet down work during demolition operations to prevent dust from arising. Provide maximum practicable protection from inclement weather for materials, equipment, and personnel located in partially dismantled structures. Provide shoring or bracing where necessary to prevent settlement or displacement of existing or new structures..
- B. Cap or plug with brick and mortar, as indicated, pipes and other conduits abandoned due to demolition.

3.03 SALVAGE:

Materials, equipment, and appurtenances removed, that are not designated for relocation, become property of Owner. For Owner designated refuse, haul from site and dispose of at no additional compensation.

Contractor shall keep the following for reuse: RTU unit located inside the building and the tower and antenna outside the existing building.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide labor, material, tools and equipment to prepare site as indicated and specified.

1.02 RELATED WORK:

- A. Section 02210: Earth Excavation, Backfill, Fill and Grading

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXISTING TREES AND VEGETATION:

- A. Avoid cutting or injuring trees and vegetation outside easement line and outside areas to be cleared as indicated, without Engineer's permission.
- B. Accept responsibility for damages outside these lines.
- C. Remove trees within permanent and temporary easement as designated by Engineer.

3.02 EXISTING STRUCTURES AND PROPERTY:

- A. Remove existing signs, posts, catchbasin frames and grates, manhole frames and covers, and granite curbing within construction path unless directed otherwise.
- B. Store at a site designated by Owner, items in reusable condition as determined by Engineer or Owner.

3.03 CLEARING:

- A. Cut or remove trees, brush, and other vegetable matter such as snags, bark and refuse, from areas to be cleared. Clear ground to width of permanent easement unless otherwise directed.
- B. Cut trees, stumps, and stubs to be cleared, except where clearing done by machinery, as close to ground surface as practicable, but no more than 6 in. above ground surface for small trees and 12 in. for larger trees.

- C. Bury elm bark, at least 1 ft. deep, or burn in incinerators off site with antipollution controls and fire prevention controls, to prevent spread of Dutch Elm disease as required by applicable laws.

3.05 GRUBBING, STRIPPING, DISPOSAL:

- A. Remove stumps and roots larger than 3 in. in diameter to a depth of 12 in., and roots larger than 1/2 in. in diameter to a depth of 6 in. Measure depths to cut from existing ground surface or proposed finished grade, whichever is lower.
- B. Strip stumps, roots, foreign matter, topsoil and unsuitable earth from ground surface. Utilize topsoil insofar as possible for finished surfacing.
- C. Promptly dispose off site material from clearing and grubbing not reused or stockpiled. In doing so, observe all applicable laws, ordinances, rules and regulations. Do not consider work completed until final cleaning, unless otherwise directed.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02210

EARTH EXCAVATION, BACKFILL, FILL AND GRADING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Perform the following earth excavation, backfill, fill and grading as indicated or specified:
 - 1. Make excavations to accommodate piping, conduits, foundations and other structures.
 - 2. Provide materials for backfilling excavations and constructing embankments and fills as indicated and specified.
 - 3. Construct embankments of compacted materials.
 - 4. Grade surfaces to meet finished grades indicated.
 - 5. Immediately notify the Engineer if suspected hazardous materials are encountered and cease operations in that part of work.
 - 6. Remove boulders within the excavation limits.

1.02 RELATED WORK:

- A. Section 01568: Erosion Control Sedimentation and Containment of Construction Materials.
- B. Section 02100: Site Preparation.
- C. Section 03300: Cast-in-Place Concrete

1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. C33: Specification for Concrete Aggregates.
 - 2. C136: Sieve Analysis of Fine and Coarse Aggregates.
 - 3. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

4. D422: Test Method for Particle-Size Analysis of Soils.
5. D1140: Test Method for Amount of Material in Soils Finer than the No. 200 (75 Fm) Sieve.
6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
7. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (600 kN-m/m³)).
8. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
9. D2922: Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods. (Shallow Depth).
10. D3017: Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
11. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
12. D4718: Practice for Correction of Unit Weight and Water Content for Soils Containing Oversized Particles.
13. D4944: Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Pressure Tester Method.
14. D4959: Test Method for Field Determination of Water (Moisture) Content of Soil by Direct Heating Method.
15. D5080: Test Method for Rapid Determination of Percent Compaction.

- B. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

1.04 DEFINITIONS:

- A. Percentage of compaction is defined as the ratio of the field dry density, as determined by ASTM D1556 to the maximum dry density determined by ASTM D1557 Procedure C, multiplied by 100.
- B. Proof Roll: Compaction with a minimum of 4 passes of a vibratory steel drum or rubber tire roller. Vibratory plate compactors shall be used in small areas where vibratory steel drum or rubber tire roller can not be used.

- C. Acceptable Material: Material which does not contain organic silt or organic clay, peat, vegetation, wood or roots, stones or rock fragments over 6-inch [15 cm] in diameter, porous biodegradable matter, loose or soft fill, excavated pavement, construction debris, or refuse. Stones or rock fragments shall not exceed 40 percent by weight of the backfill material.
- D. Unacceptable Materials: Materials does not comply with the requirements for the acceptable material or which cannot be compacted to the specified or indicated density.

1.05 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Qualifications of the Contractor's Independent Testing Laboratory as specified in Paragraph 1.06 I, four (4) weeks prior to the execution of any earth excavation, backfilling, filling, or compaction process.
 - 2. Submit an excavation, backfilling, and filling plan at least two weeks prior to start of any earth moving activities. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include, but not be limited to the following items:
 - a. Detailed sequence of work.
 - b. General description of construction methods.
 - c. Numbers, types, and sizes of equipment proposed to perform excavation and compaction.
 - d. Details of dust control measures.
 - e. Proposed locations of stockpiled excavation and/or backfill materials.
 - f. Proposed surplus excavated material off-site disposal areas and required permits.
 - g. Details of erosion and sedimentation control measures which will prevent erosion and sedimentation during the earth moving activities.
 - 3. Laboratory testing results of gradation and moisture-density relationship. Submittal shall include specific location of the source and the date when sample was taken.

4. During Construction, submit written confirmation of fill lift thickness, in-place soil moisture content, and percentage of compaction to the Engineer before placing the next lift or constructing foundations.

1.06 QUALITY ASSURANCE AND CONTROL:

- A. Provide in accordance with Section 01400 and as specified.
- B. The Contractor shall be solely responsible for making all excavations in a safe manner. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P) and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.
- C. Do not excavate, construct embankments, or fill until all the required submittals have been reviewed by the Engineer.
- D. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.
- E. Field Testing and Inspections:
 1. By Contractor's independent testing laboratory, acceptable to the Engineer, at Contractor's expense as specified in Paragraph 1.06 G.
 2. Location of tests mutually acceptable to testing laboratory and the Engineer or as directed by the Engineer.
 3. In the event compacted material does not meet specified in-place density, recompact material and retest this area until specified results are obtained at no additional to the Owner.
 4. Contractor's testing laboratory to perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.
 5. Owner will retain the services of an independent testing laboratory to conduct confirmatory testing and inspection.
- F. Methods of Field Testing:
 1. In-Place Density: ASTM D1556, ASTM D2167, or ASTM D2922.
 2. In-Place Moisture Content: ASTM D3017, ASTM D4944, or ASTM D4959.

G. Material Testing Frequency: The following testing frequencies are minimum required for all structural and non-structural fill, grading and embankment.

1. Field In-Place Density and Moisture Content - Screened gravel and crushed stone shall be compacted as specified and indicated. For other backfill and fill materials, minimum test frequency shall be as follows, and no less than one test per:
 - a. Trenches under structures foundation preparation or roadways subbase: Every 1000 lin. ft. [300 m.] per lift.
 - b. Trenches in areas without structures or roadways: Every 1000 lin. ft. [300 m.] per alternate lift.
 - c. Paved Roadways: Every 200 lin. ft. [60 m.] per lift.
 - d. Paved Areas: 3,500 sq. ft. [350 sq. m.] per lift.
 - e. Under Structure: 1,000 sq. ft. [100 sq. m.] per lift.
 - f. Around Structures: 1,500 sq. ft. [150 sq. m.] per lift.
 - g. Embankment Fills: 10,000 sq. ft. [1000 sq. m.] per lift.
2. Moisture Density - One per source, except for screened gravel and crushed stone. Repeat the moisture density test for every 5,000 cubic yard of material use, and whenever visual inspection indicates a change in material gradation as determined by the Engineer.
3. Gradation Analysis - A minimum of one per source and for each moisture density test and whenever visual inspection indicates a change in material gradation.
4. Owner's testing laboratory to conduct confirmatory testing at a minimum frequency of 25% of the specified frequencies in paragraph 1.06.H, or as directed by Owner's Engineer.

H. Construction Tolerances:

1. Construct finished surfaces to plus or minus 1 inch [2.5 cm] of the elevations indicated.
2. Grade cut and fill areas to plus or minus 0.20 foot [6.0 cm] of the grades indicated.
3. Complete embankment edges to plus or minus 6 inches [15 cm] of the slope lines indicated.

4. Provide the Engineer with adequate survey information to verify compliance with above tolerances.
- I. Cut pavement with a saw or pneumatic tools to prevent damage to remaining pavement without extra compensation. Where pavement is removed in large pieces, dispose of pieces before proceeding with excavation.
- J. Pipes, drains, and other utilities may exist in certain locations not indicated on drawings. No attempt has been made to show all services. Completeness or accuracy of information given is not guaranteed.
- K. Dig test pits considered as incidental to the normal excavation as indicated and specified in this Section, at no additional compensation.
- L. Carefully support and protect from damage, existing pipes, poles, wires, fences, curbing, property line markers, and other structures, which the Engineer determines must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore without compensation therefore, to at least as good condition as that in which they were found immediately before the work was begun.
- M. Whenever certain existing structures, as described below, are encountered, and the Engineer so directs, change the location, remove and later restore, or replace such structures, or assist the Owner in doing so.
- N. In removing existing pipes or other structures, include for payment only those new materials which are necessary to replace those unavoidably damaged as determined by the Engineer.
- O. The preceding two paragraphs apply to pipes, wires, and other structures which meet the following: (a) are not indicated on the drawings or otherwise provided for, (b) encroach upon or are encountered near and substantially parallel to the edge of the excavation, and (c) in the opinion of the Engineer, will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.
- P. Restore existing property or structures as promptly as practicable.
- Q. If material unacceptable for foundation (in the opinion of the Engineer) is found at or below the grade to which excavation would normally be carried in accordance with the drawings and/or specifications, remove such material to the required width and depth as directed by the Engineer and replace it with screened gravel, select borrow, or concrete.
- R. Do not remove excavation materials from the site of the work or dispose of except as directed or permitted by the Engineer.

- S. Haul away and dispose of surplus excavated materials at locations directed by the Engineer at no additional cost to the Owner.
- T. During progress of work, conduct earth moving operations and maintain work site so as to minimize the creation and dispersion of dust. Furnish and spread calcium chloride if the Engineer decides that it is necessary for more effective dust control.
- U. Provide suitable and safe bridges and other crossings where required for accommodation of travel, and to provide access to private property during construction, and remove said structures thereafter.

1.07 SITE CONDITIONS:

- A. Subsurface Conditions: Refer to Front End documents and Geotechnical Report.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Use only acceptable materials from excavations or borrows.
- B. Provide 1,500 psi [10 MPa] concrete.
- C. Provide Fine Aggregate conforming to ASTM C33.

2.02 EQUIPMENT:

- A. The compaction equipment shall be selected by the Contractor, and shall be capable of consistently achieving the specified compaction requirements. The selected compaction equipment shall meet the following minimum requirements:
 - 1. Manually operated vibratory plate compactors weighing no less than 200 pounds [90 kg] with vibration frequency no less than 1600 cycles per minute.
 - 2. Vibratory steel drum or rubber tire roller weighing at least 12,000 pounds [5450 kg].

PART 3 - EXECUTION

3.01 SITE MAINTENANCE:

- A. Roadway and Site Leveling: Grade roadway and site as to maintain them in a level unrutted condition and to eliminate puddling of surface and subsurface water.

3.02 EXCAVATION:

- A. Execution of any earth excavation shall not commence until the related excavation support systems, and backfill and fill materials submittals are reviewed by the Engineer and all Engineer's comments satisfactorily addressed.
- B. Carry out program of excavation, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or of work previously completed under this contract.
- C. Excavate to widths that give suitable room for building structures or laying and jointing piping.
- D. Do not plow, scrape or dig by machinery near to finished subgrade in a manner that would result in disturbance of subgrade.
- E. Excavate to lines and grades indicated in an orderly and continuous program.
- F. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.
- G. Excavate to elevations indicated, or deeper, as directed by the Engineer, to remove unacceptable bottom material.
- H. Exercise care to preserve material below and beyond the lines of excavations.
- I. Place excavated material at the approved stockpile locations and in no case closer than 3 feet [90 cm] from edge of excavations to prevent cave-ins of bank slides.
- J. Regard small, less than one cubic yard, boulders, rock fragments, and concrete encountered during excavation as a normal part of in-place soils and not included for payment as rock.

3.03 SEPARATION OF EXCAVATED MATERIALS FOR REUSE:

- A. Remove only existing pavement that is necessary for prosecution of work.

- B. Carefully remove loam and topsoil from excavated areas. Store separately for further use or furnish equivalent loam and topsoil as directed.
- C. Carefully remove acceptable material from excavated areas and store separately for further use as backfill material.

3.04 TRENCH EXCAVATION:

- A. When pipe is to be laid in gravel bedding or concrete cradle, excavate trench by machinery to, or just below designated subgrade. If material remaining at bottom of trench is disturbed, recompaction shall be required.
- B. When pipe is to be laid directly on bottom of trench, do not excavate lower part of trenches by machinery to subgrade. Remove remainder of material to be excavated just before placing of pipe by use of hand tools. Form a flat or shaped bottom, true to grade, so pipe will have a uniform and continuous bearing. Support on firm and undisturbed material between joints, except for limited areas where use of pipe slings have disturbed bottom.

3.05 DEPTH OF TRENCH:

- A. Excavate trenches to depths so as to permit pipe to be laid at elevations, slopes, or depths of cover indicated on drawings, and at uniform slopes between indicated elevations.

3.06 WIDTH OF TRENCH:

- A. Make pipe trenches as narrow as practicable and do not widen by scraping or loosening materials from the sides. Make every effort to maintain sides of trenches firm and undisturbed until backfilling has been placed and compacted.
- B. Excavate trenches with approximately vertical sides between springline of pipe and elevation 1 ft. [30 cm] above top of pipe.

3.07 TRENCH EXCAVATION IN FILL:

- A. Place and compact material to top of fill or to a minimum height of 1 ft. [30 cm] above top of pipe, whichever is less, when pipe is to be laid in embankment or other recently filled material. Take particular care to ensure maximum consolidation of material under pipe location. Excavate pipe trench as though in undisturbed material.

3.08 EXCAVATION NEAR EXISTING STRUCTURES:

- A. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.
- B. Excavate test pits when determination of exact location of pipe or other underground structure is necessary for doing work properly.

3.09 REMOVAL OF SUBSURFACE OBSTRUCTIONS:

- A. Remove indicated subsurface structures and related obstructions to extent shown.
- B. Promptly notify the Engineer when any unexpected subsurface facilities are encountered during excavation such as utility lines and appurtenances, walls and foundations.

3.10 UNAUTHORIZED EXCAVATION:

- A. When the bottom of any excavation for structures is taken out beyond limits indicated or specified, backfill, with screened gravel and crushed stone wrapped with non-woven geotextile fabric or with 1,500 psi (10 Mpa) concrete.

3.11 REUSE AND DISPOSAL OF SURPLUS EXCAVATED MATERIALS:

- A. Reuse surplus acceptable excavated materials for backfill; deposit neatly and grade so as to make or widen fills, flatten side slopes, or fill depressions; or legally dispose off-site; all as directed or permitted and without additional compensation.

3.12 SUBGRADE PREPARATION AND PROTECTION:

- A. Remove loam and topsoil, loose vegetable matter, stumps and large roots from areas upon which embankments will be built or material will be placed for grading. Shape subgrade as indicated on drawings, and prepare by forking, furrowing, or plowing so that the first layer of new material placed thereon will be well bonded to it.
- B. As directed by the Engineer, overexcavate unacceptable materials below the foundation subgrade. Backfill the overexcavation with compacted screened gravel or crushed stone wrapped with nonwoven geotextile fabric. In no case shall the screened gravel be placed directly on the exposed subgrade prior to placing the geotextile fabric.
- C. Proof roll the foundation subgrade prior to backfilling and filling operation, or placing foundation concrete.
- D. Proof roll the pipe trench foundation subgrade prior to backfilling and filling operation, or placing soil-supported pipeline.

- E. Utilize excavating equipment equipped with a toothless or smooth edged, excavating bucket to expose the pipe trench foundation subgrade to avoid disturbance of the bearing surface. Tamp the exposed subgrade with the excavating bucket prior to backfilling and filling operation, or placing soil-supported pipeline.

3.13 CARE AND RESTORATION OF PROPERTY:

- A. Enclose uncut tree trunks adjacent to work in wooden boxes of such height as may be necessary for protection from injury from piled material, equipment, operations, or otherwise due to work. Operate excavating machinery and cranes of suitable type with care to prevent injury to trees not to be cut and particularly to overhanging branches and limbs.
- B. Cut all branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint as directed.
- C. Protect cultivated hedges, shrubs, and plants which might be injured by the Contractor's operations by suitable means or dig up and temporarily replant and maintain. After construction operations have been substantially completed, replant in original positions and care for until growth is reestablished. If cultivated hedges, shrubs, and plants are injured to such a degree as to effect their growth or diminish in their beauty or usefulness, replace by items of equal kind and quality existing at the start of the work.
- D. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces when their treads or wheels of which are so shaped as to cut or otherwise damage such surfaces.
- E. Restore surfaces damaged by the Contractor's operations to a condition at least equal to that in which they were found immediately before work commenced. Use suitable materials and methods for such restoration.

3.14 BACKFILLING - GENERAL:

- A. Do not place, spread, roll or compact fill material during unfavorable weather conditions. If interrupted by heavy rain or other unfavorable conditions, do not resume until ascertaining that the moisture content and density of the previously placed soil are as specified.
- B. Do not use puddling, ponding or flooding as a means of compaction.

3.15 MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS:

A. Select Borrow, and Fine Aggregate:

1. Dump and spread in layers not to exceed 8-in. [20 cm] uncompacted thickness.
2. Compact, fill and backfill under structure and bedding for pipes (from below pipe to spring line) as indicated but to not less than 95 percent. Compact to not less than 90 percent in other areas unless otherwise indicated.

B. Screened Gravel and Crushed Stone:

1. Dump and spread in layers not to exceed 8-in. [20 cm] uncompacted thickness.
2. Compact using self propelled vibratory steel drum or rubber tire rollers with a minimum of 4 passes in directions perpendicular to one another in open areas. In small areas, use manually operated vibratory plate compactors with a minimum of 4 passes.

C. Bank-run Gravel and Acceptable materials for use as non-structural fill:

1. Dump and spread in layers not to exceed 12-in. [30 cm] uncompacted thickness.
2. Compact to not less than 90 percent unless otherwise indicated.

D. Backfilling and filling operation shall be suspended in areas where tests are being made until tests are completed and the testing laboratory has advised the Engineer that adequate densities are obtained.

3.16 STRUCTURAL FILL AND BACKFILL UNDER STRUCTURES:

- #### A. Compact fill and backfill under structures and pavements with screened gravel, crushed stone, select borrow, or fine aggregate as specified and indicated.

3.17 NON-STRUCTURAL BACKFILL AROUND STRUCTURES:

- #### A. Use acceptable materials for non-structural backfill around structures and compacted as specified and indicated.
- #### B. Conduct hydraulic testing as soon as practicable after structures are constructed and other necessary work has been done. Start backfilling promptly after completion of tests.
- #### C. Deposit material evenly around structure to avoid unequal soil pressure.

- D. Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking, or other damage.

3.18 BACKFILLING PIPE TRENCHES:

A. General:

1. Begin backfilling and proceed until completed after: the pipes and conduits have been laid, joints have acquired maximum degree of hardness, pipelines and conduits have successfully passed tests and inspections as required in the Specifications, and concrete or masonry structures within the trench have reached their design strength to support all loads.
2. Backfill and compact indicated material under, around, and above pipes, conduits, and other structures to the indicated or specified compaction density requirement. Utilize compaction devices which will not damage the pipe, conduit, or structure within the trench.
3. Do not drop backfill material into trench from a height of more than 5 ft. [150 cm], or in a manner which will damage the pipe, conduit, or other structure within trench.

B. Pipe Trenches:

1. Materials:
 - a. From below pipe to 1 ft. [30 cm] above top of pipe: Use screened gravel, or crushed stone, unless otherwise indicated.
 - b. One foot [30 cm] above top of pipe to finished grade or to pavement subbase: Use bank-run gravel or acceptable materials, unless otherwise indicated.
2. Compacting Around Pipes: Compact material around circumference of pipe and the area between the trench wall and the pipe by hand tamping in 6 inches [15 cm] layers.
3. Compacting Above Pipe: Compact material by hand tamping. If trench width is wide enough to accommodate power tools and the compacted material over the pipe will support the load of the power tools without damage to the pipe, use rollers or other powered compaction equipment able to more readily achieve compaction requirements.

3.19 MATERIAL FOR FILLING AND EMBANKMENTS:

- A. Use acceptable materials for filling and building embankments unless otherwise indicated.

3.20 PLACING AND COMPACTING EMBANKMENT MATERIAL:

- A. Compact fill material as specified and indicated.
- B. Perform fill operation in an orderly and systematic manner using equipment in proper sequence to meet the specified compaction requirements.
- C. Place fill on surfaces which are free of unacceptable materials.
- D. Begin filling in lowest section of work area. Grade surface of fill approximately horizontal but provide with sufficient longitudinal and transverse slope to allow for runoff of surface water from every point.
- E. Conduct filling so that no obstruction to drainage from other sections of fill area is created at any time.
- F. Reduce moisture content of fill material, if necessary, in source area by working it over under warm and dry atmospheric conditions. A large disc harrow with two to three foot diameter disks may be required for working soil in a drying operation.
- G. Compact uniformly throughout. Keep surfaces of fill reasonably smooth and free from humps and hollows which would prevent proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same layer but direct equipment to spread out to prevent overcompaction in localized areas. Take care in obtaining thorough compaction at edges of fill.
- H. Slightly slope surface of fill to ensure drainage during periods of wet weather. Do not place fill while rain is falling or after a rain-storm until the Engineer considers conditions satisfactory. During such periods and upon suspension of filling operations for any period in excess of 12 hours, roll smooth the surface of fill using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, remove muddy material off surface to expose firm, compacted material, as determined by the Engineer.
- I. When fill is placed against an earlier fill or against in-situ material under and around structures, including around piping beneath structures or embankments, slope junction between two sections of fill, 1 vertical to 1.5 horizontal. Bench edge of existing fill 24-in. [60 cm] to form a serrated edge of compact stable material against which to place the new fill. Ensure that rolling extends over junction between fills.

- J. When fill is placed directly upon another older fill, clean surface thoroughly of debris and remove any loose material. Then proof roll the entire old surface.
- K. After spreading each loose lift to the required thickness and adjusting its moisture content as necessary, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction of an entire lift. Do not make additional passes until previous pass has been completed.
- L. In case material of any fill sinks and weaves under roller or under hauling units and other equipment, required degree of compaction is not being obtained. Reduce the moisture content. If such sinking and weaving produces surface cracks, suspend operations on that part of the embankment until it becomes sufficiently stabilized. Ideal condition in fill is that attained when the entire fill below the surface being rolled is so firm and hard as to show only the slightest weaving and deflection as roller passes. Spread out rolling operations over the maximum practicable area to minimize condition of sinking and weaving.
- M. If because of defective workmanship, compaction obtained over any area is less than that required, remedy condition at no cost to Owner. If additional rolling or other means fail to produce satisfactory results, remove material in that area down to a level of satisfactory density. Perform removal, replacement, and rerolling without additional compensation.

3.21 COMPACTION CONTROL OF BACKFILL, FILL, AND EMBANKMENT:

- A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified or if not specified, at a level slightly lower than optimum.
- B. The soil testing laboratory shall provide inspection during filling or backfilling operations to ensure compaction of screened gravel or crushed stone and record compaction equipment in use.
- C. Moisture control may be required either at the stockpile area, pits, or on embankment or backfill. Increase moisture content when material is too dry by sprinkling or other means of wetting uniformly. Reduce moisture content when material is too wet by using ditches, pumps, drainage wells, or other devices and by exposing the greatest possible area to sun and air in conjunction with harrowing, plowing, spreading of material or any other effective methods.

3.22 ALLOWANCE FOR SHRINKAGE:

- A. Build embankments or backfill to a height above finished grade which will, in the opinion of the Engineer, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.
- B. Supply specified materials and build up low places as directed, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.23 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02615

DUCTILE-IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test ductile-iron pipe and fittings, as indicated and specified.
- B. Options:
 - 1. For buried exterior pipelines provide push-on joint pipe.
 - a. Provide restrained push-on pipe as indicated and specified
 - b. Provide either restrained push-on joint fittings as specified and indicated or provide mechanical joint fittings with restraint system as specified herein
 - 2. For piping exposed as in buildings and galleries, provide flanged or rigid-joint, grooved-coupled pipe and fittings.
 - 3. Cast iron pipe and fittings are not acceptable

1.02 RELATED WORK:

- A. Section 02210: Earth Excavation, Backfill, Fill and Grading
- B. Section 03200: Concrete Reinforcement
- C. Section 15056: Pipe Supports
- D. Section 15101: Process Valves and Appurtenances
- E. Section 09941: Field Painting

1.03 REFERENCES:

- A. American National Standards Institute, Inc. (ANSI) Standards:
 - 1. A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. A21.10: Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.

3. A21.11: Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings.
4. A21.15: Flanged Ductile-Iron Pipe with Threaded Flanges.
5. A21.50: Thickness Design of Ductile-Iron Pipe.
6. A21.51: Ductile-Iron Pipe, Centrifugally Cast in Metal Molds, or Sand-Lined Molds, for Water or Other Liquids.
7. A21.53: Ductile-Iron Compact Fittings, 3-in through 16-in. for Water and Other Liquids.
8. B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
9. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges.
10. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings.

B. American Society for Testing and Materials (ASTM) Publications:

1. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile.
2. C283: Test Method for Resistance of Porcelain Enameled Utensils to Boiling Acid.
3. D1248: Polyethylene Plastics Moulding and Extrusion Materials.

C. American Water Works Association (AWWA) Standards:

1. C105: Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
2. C651: Disinfecting Water Mains.
3. C606: Grooved and Shoulder Joints.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01300:

1. Piping layouts in full detail.
2. Location of pipe hangers and supports.
3. Location and type of backup block or device to prevent joint separation.

4. Large scale details of wall penetrations and special castings.
 5. Schedules of all pipe, fittings, special castings, couplings, expansion joints, and other appurtenances.
- B. Certificates: Sworn and notarized certificates in duplicate of shop tests showing compliance with appropriate standard.
- C. Manufacturer's Literature:
1. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
 2. Brochures and technical data on coatings and lining's and proposed method of application.
- 1.05 QUALITY ASSURANCE:
- A. Provide in accordance with Section 01400 and as specified.
 - B. Inspect and test at foundry according to applicable standard specifications.
 - C. Owner reserves right to inspect and test by independent service at manufacturer's plant or elsewhere at his own expense.
 - D. Visually inspect before installation.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01610 and as specified.

PART 2 - PRODUCTS

2.01 PIPE:

- A. Ductile Iron:
 1. Design conforming to ANSI A21.50.
 2. Manufacture conforming to ANSI A21.15 or ANSI A21.51.
 3. Thickness class, unless otherwise indicated or specified:
 - a. Minimum Thickness Class 52.
 - b. Minimum thickness Class 53 for use with threaded flanges.

- c. Minimum thickness Class 53 for use with flanged pipe.
- d. Minimum thickness for use with grooved couplings conforming to AWWA C606.

2.02 PIPE FOR USE WITH COUPLINGS:

- A. As specified above except ends shall be plain.
- B. With bolted split sleeve couplings, ends cast or machined at right angles to axis.
- C. With grooved type coupling:
 - 1. Ductile-Iron of thickness class specified above.
 - 2. Grooved End dimensions conforming to AWWA C606 for flexible or rigid joints to suit joint requirements.

2.03 FLEXIBLE JOINT PIPE:

- A. Provide joints with maximum deflection 15 degrees in any direction from pipe axis. Joint design to prevent pulling apart, and to remain watertight at any deflection angle within specified range.
- B. Provide boltless type with rubber gaskets.
- C. Pipe barrel thickness: According to manufacturer's standard but not less than AN Standard for pipe of corresponding class.
- D. Machine joint contact surfaces spherical, without depressions or chatter marks, or rough tool cuts.
 - 1. Smooth by grinding, and buffing.
 - 2. Machining accuracy: Finished pipes interchangeable without loss of watertightness or flexibility.
 - 3. Protect spherical spigot and plain ends of cut lengths by fastened wood lagging.

2.04 FITTINGS:

- A. Provide fittings conforming to ANSI A21.10 or ANSI A21.53, at least Class 150.
- B. Provide all bell push-on or mechanical-joint fittings unless otherwise indicated or specified.

- C. Face and drill flanged fittings conforming to ANSI A21.10 except special drilling or tapping as necessary for correct alignment and bolting.
- D. If flanged fittings are not available under ANSI A21.10 provide fittings conforming to ANSI B16.1 in 125 lb. pressure class.
- E. Provide standard base fittings where indicated.
- F. Provide grooved-end fittings ductile-iron conforming to ANSI A21.10 (AWWA C110) for center-to-face dimensions.
 - 1. End preparation for grooved-ends conforming to AWWA C606 for flexible or rigid joints as required by type of joint.

2.05 NONSTANDARD FITTINGS:

- A. Acceptable design.
- B. Same diameter and thickness as standard fittings.
- C. Manufactured to meet requirements of same specifications as standard fittings except for laying length and types of ends.

2.06 WALL CASTINGS:

- A. Provide size and type indicated.
- B. Wall Castings: Conform to requirements of ANSI A21.10 or fabricate of Class 53 ductile iron pipe with screwed on flanges and welded on waterstop.
- C. Provide water stop centered in wall. Weld water stops on in factory under controlled conditions to ensure adequate strength to permit waterstop to absorb thrust up to the pressure rating of the pipe.

Wall Castings with annealed ductile iron water stops

Pipe Size	Waterstop thickness, in
4"-12" [100-300 mm]	0.50 [13 mm]
14"-24" [350 -600 mm]	0.75 [19 mm]
30"-36" [750-900 mm]	1.00 [25 mm]
42"-48" [1100-1200 mm]	1.25 [32 mm]

Wall Castings with fabricated steel water stops

Pipe Size	Waterstop thickness, in
4"-16" [100-400 mm]	0.25 [6 mm]

18"-24" [450 -600 mm]	0.38 [10 mm]
30"-36" [750-900 mm]	0.50 [13 mm]
42"-48" [1100-1200 mm]	0.75 [19 mm]
54"-64" [1100-1200 mm]	1.00 [25 mm]

- D. On flanged wall castings, provide space between the wall and flange to permit mounting the nuts on the flange bolts.
- E. Flanged wall castings located with the flange flush with the wall are not acceptable.
- F. Locate push-on joint wall castings with space between the bell and the wall to insert the follower bolts.
- G. As an option, fabricated wall pipe of Schedule 40 Type 316L stainless steel may be substituted for wall castings specified above. Provide with waterstops of above dimensions and welded continuously on both sides of stop. Flanges of Type 316 stainless steel. Bolts for connection to buried pipe Type 316 stainless steel. Provide flange insulation gaskets, sleeves and washers for all flanges.

2.07 ADAPTERS:

- A. Furnish and install for joining pipe of different types, unless solid sleeves indicated.
 - 1. Provide ends conforming to above specifications for appropriate type of joint, to receive adjoining pipe.
 - 2. Joining two classes of pipe may be of lighter class provided annular space in bell-and-spigot type joints sufficient for jointing.

2.08 JOINTS:

- A. Provide push-on joint and mechanical joint pipe as indicated with necessary accessories, conforming to ANSI A21.11.
 - 1. Provide gasket composition suitable for exposure to liquid within pipe.
 - 2. Provide mechanical joint gaskets with copper tips to provide electrical continuity.
 - 3. Provide serrated brass wedges for push-on joints to provide electrical continuity; two per joint for pipe 12-in. and smaller and four per joint for larger pipe.
- B. Provide pipe flanges and accessories conforming to ANSI A21.15.
 - 1. Provide flat faced flanges.
 - 2. Provide 1/8 in. thick, full faced gaskets suitable for exposure to liquid within pipe.

C. Provide restrained joint on pipe and fittings where indicated. Provide restrained joint which is:

1. Boltless
2. Capable of being deflected after assembly
3. Designs using set screws or requiring field welding are not acceptable.
4. Manufacturers:
 - a. American Cast Iron Pipe Co. Flex-Ring.
 - b. U.S. Pipe TR FLEX.
 - c. Clow Super-Lock.
 - d. Or acceptable equivalent.

2.09 MECHANICAL JOINT FITTINGS – RESTRAINT SYSTEM

A. Provide restraint devices for pipe consisting of multiple gripping wedges incorporated into a follower gland meeting requirements of ANSI/AWWA C110/A21.10.

1. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, retaining full mechanical joint deflection during assembly and allowing joint deflection after assembly.
2. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.
3. Provide restraint devices Listed by Underwriters Laboratories (3” through 24” inch size) and Approved by Factory Mutual (3” through 12” inch size).

B. Working Pressure Rating:

1. 16-in and Smaller: 350 psi
2. 18-in and Larger: 250 psi
3. Minimum safety factor of 2 to 1.

C. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.
3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.
6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTR's) available, in hard copy.

D. Manufacturer:

1. EBAA Iron MegaLug Series 1100 or acceptable equivalent product

2.10 FLANGE ADAPTORS:

A. Provide restrained flange adaptors for pipe consisting of multiple individual gripping wedges incorporated into a follower gland meeting requirements of ANSI/AWWA C110/A21.10.

1. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.
2. Provide restraint devices Listed by Underwriters Laboratories (3-in through 12 in size) and Approved by Factory Mutual (4-in through 12-in size).

B. Joint Deflection capability:

1. 3-in thru 8-in: 5 degrees
2. 10-in and 12-in: 3 degrees
3. 14-in and 16-in: 2 degrees
4. 18-in and 20-in: 1.5 degrees
5. 20-in, 42-in and 48-in: 1 degree

6. 30-in and 36-in: 3 degrees

C. Provide flange adaptor to maintain seal with and 0.6 inch gap between end of pipe and mating flange

D. Working Pressure Rating:

1. 16-in and Smaller: 350 psi
2. 18-in: 300 psi
3. 24-in: 200 psi
4. 30-in thru 48-in: 150 psi
5. Minimum safety factor of 2 to 1.

E. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.
3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.
6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTR's) available, in hard copy.

F. Manufacturer:

1. EBAA Iron MegaFlange Series 2100 or acceptable equivalent product

2.11 FLEXIBLE CONNECTIONS:

A. Use as specified or indicated:

1. Bolted split sleeve couplings
2. Grooved couplings
3. Expansion joints

2.12 BOLTED SPLIT SLEEVE COUPLINGS:

- A. Provide in accordance with Section 15370.
- B. Pressure rating at least equal to that of related pipeline.
- C. Provide with gaskets of composition suitable for exposure to liquid within pipe.
- D. Provide gaskets with copper tips for electrical continuity through joints.

2.13 GROOVED COUPLINGS:

- A. Conform to AWWA C606.
- B. Minimum pipe wall thickness specified under "Pipe For Use With Couplings."
- C. Where grooved couplings are indicated to provide for expansion or flexibility, cut pipe grooves to provide necessary expansion or flexibility.
- D. Where grooved couplings are used instead of flanged joints, joint to be of rigid type with pipe grooves cut to bring pipe ends together. Beam strength of joint shall be equal to or greater than that of flanged joint.

2.14 EXPANSION JOINTS:

- A. Provide in accordance with Section 15370.
- B. Pressure rating at least equal to that of related pipeline.

2.15 FILLING RINGS:

- A. Provide where necessary.
- B. Materials, workmanship, facing, and drilling, conforming to 125-lb. ANSI Standard.
- C. Suitable length with nonparallel faces and corresponding drilling, if necessary, for correct assembly of adjoining piping or equipment.

2.16 CONNECTIONS - TAPPED:

- A. Provide service saddles for all taps for lines 24-inch and smaller.
 - 1. Body: Ductile iron ASTM A395 or Bronze.
 - 2. Straps and Hardware: Type 316 stainless steel.
- B. For 30-in and larger provide watertight joint with adequate strength against pullout. Use only tapered thread taps.
 - 1. Maximum size of taps in pipe or fittings without bosses not to exceed that listed in appropriate table of Appendix to ANSI A21.51 based on: 2 full threads.
 - 2. Where size of connection exceeds that given above for pipe, provide boss on pipe barrel or use tapping saddle. Make tap in flat part of intersection of run and branch of tee or cross, or connect by means of tapped tee, branch fitting and tapped plug or reducing flange, or tapping tee and tapping valve, as indicated or permitted.
 - 3. Provide taps and piping for gauges and pressure sensing instruments in accordance with ANSI/HI standards so that there are no erroneous readings.

2.17 STANDARD LINING AND COATING:

- A. Inside of pipe and fittings: Provide double thickness cement lining and bituminous seal coat conforming to ANSI A21.4.
- B. Outside of pipe and fittings within structures: Clean and apply one shop coat with a 3 to 5 mill DFT of moisture cured urethane.
- C. Outside surfaces of castings to be encased in concrete: No coating.
- D. Machined surfaces cleaned and coated with rust-preventative compound at shop.
- E. Outside of buried pipe and fittings: Standard bituminous coating conforming to appropriate AN Standard.

2.18 GLASS LINING:

- A. Provisions:
 - 1. Pipe: Provide glass lining fused to metal base by firing entire pipe or fitting to temperature above 1,400 deg. F. and held at temperature for sufficient time to develop smooth vitreous lining which has molecular bond with metal.
 - 2. Lining: Provide minimum of 0.008-in. thick and withstanding instantaneous thermal shock of 350 deg. F. differential, without crazing, blistering, or spalling. Lining free of pinholes which expose metal.

3. Provide lining hardness of 5 to 6 on the Mohs scale, and of density 2.5 to 3.0 grams per cubic centimeter.
4. Test in accordance with ASTM C283.

2.19 POLYETHYLENE LINING:

- A. Material: Virgin polyethylene conforming to ANSI/ASTM D1248, compounded with a sufficient amount of carbon black to provide resistance to ultraviolet rays.
- B. Bond polyethylene to pipe and fittings by heating.
- C. Surface Preparation:
 1. Blast clean comparable to the requirements of SSPC-SP6.
- D. Lining Thickness: Nominal 40 mils.

2.20 GASKETS, BOLTS, AND NUTS:

- A. Provide ring or full face synthetic rubber gaskets for flanged joints and neoprene faced phenolic for insulating gaskets.
 1. 1/8 in. [3 mm] thick.
- B. Make flanged joints with:
 1. Bolts.
 2. Bolt studs with nut on each end.
 3. Studs with nuts where flange is tapped.
 4. Plastic bolt sleeves and washers for insulating joints.
- C. Number and size of bolts conform to same ANS as flanges.
- D. Provide bolts and nuts, except as specified or indicated, Grade B, ASTM A307.
- E. Provide bolt studs and studs of same quality as machine bolts.
- F. Submerged flanged joints made up with Type 316 stainless steel bolts and nuts.

2.21 ELECTRICAL CONDUCTORS:

- A. Provide 1/16-in. by 3/4-in. copper strip conductors for joints indicated to have electrical continuity.
- B. Weld terminal strips to bell-ends and spigot ends of pipe in the foundry. Provide jumper strips and silicon bronze bolts and nuts to complete the connections.
- C. If field cutting of pipe is necessary, weld terminal strip to cut spigot end using thermit weld or other approved process.

PART 3 - EXECUTION

3.01 INSPECTION BEFORE INSTALLATION:

- A. Visually inspect.

3.02 HANDLING AND CUTTING:

- A. Mark pipe and fittings "Rejected" and remove from site when cracked or has received a severe blow.
- B. If permitted, cut on sound barrel at a point at least 12 in. from visible limit of crack, at Contractor's expense.
- C. Machine cut with milling type cutters, knives, or saws. Snap cutters, torch, or hammer and chisel NOT ALLOWED. Examine for possible cracks.
- D. Chamfer cut ends if used for push-on joints.
- E. Do not cut polyethelene lined pipes.
- F. Do not cut glass lined pipes.

3.03 INSTALLATION:

- A. Piping Support: Provide in accordance with Section 15056.
- B. Pipe and Fittings:
 - 1. Remove and replace defective pieces.
 - 2. Clear of all debris and dirt before installing and keep clean until accepted.
 - 3. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically.
 - 4. Provide firm bearing along entire length of buried pipelines.

5. Do not allow deflection of alignment at joints to exceed permissible deflection as specified below:

PIPE DEFLECTION ALLOWANCES

Maximum permissible deflection, in.*		
Size of pipe, in	Push-on joint	Mechanical joint
4	19	31
6	19	27
8	19	20
10	19	20
12	19	20
14	11	13-1/2
16	11	13-1/2
18	11	11
20	11	11
24	11	9
30	11	9
36	11	8
42	7-1/2	7-1/2
48	7-1/2	7-1/2
54	7-1/2	0

* Maximum permissible deflection for 20-ft. lengths; for other lengths in proportion of such lengths to 20ft.

- For push-on joint or similar pipe, clean bell of excess tar or other obstruction and wipe out before inserting next pipe spigot. Shove new pipe into place until properly seated and hold securely until joint completed.
 - Set castings to be encased in concrete accurately with bolt holes, if any, carefully aligned. Clean off rust and scale before setting.
- C. Temporary Plugs: When pipe laying not in progress, close open ends of pipe with temporary watertight plugs. If water in trench, do not remove plug until danger of water entering pipe passed.
- D. Appurtenances: Set valves, fittings and appurtenances as indicated.

3.04 JOINTS AND COUPLINGS:

A. Push-on Joints:

1. Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end.
2. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom.

B. Bolted Joints:

1. Remove rust-preventive coatings from machined surfaces.
2. Clean pipe ends, sockets, sleeves, housings, and gaskets and smooth all burrs and other defects.
3. Use torque wrench to tighten to correct range of torque not to exceed values specified below:

TORQUE RANGE VALUES

Nominal pipe size, in	Bolt diameter, in	Range of torque, ft-lb
3	5/8	40-60
4-24, incl.	3/4	75-90
30, 36	1	100-120
42, 48	1-1/4	120-150

C. Flanged Joint:

- Make up tight.
- Do not put strain on nozzles, valves, and other equipment.

D. Mechanical Joints:

- Wire brush surfaces in contact with gasket and clean gasket.
- Lubricate gasket, bell, and spigot with soapy water.
- Slip gland and gasket over spigot, and insert spigot into bell until seated.
- Seat gasket and press gland firmly against gasket.
- After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

E. Flexible Joints:

- Clean and dry before assembly.
- Place gaskets, rings, glands and followers in position in back of spigot ball.
- Coat ball and socket with thin film of lubricant conforming to joint manufacturer's standards.
- Insert ball and seat in socket. Seat gasket against ball.
- Boltless joints:
 - Assemble retainer rings and glands conforming to manufacturer's standard.
 - Lock in place with lead strips.

F. Grooved Couplings:

- Clean grooves and other parts.
- Coat ends of pipe and outside of gasket with soft soap or silicone and slip gasket over one pipe end.
- Bring pipes to correct position and center gasket over pipe ends with lips against pipe.
- Place housing sections, insert bolts and tighten nuts until housing sections in metal-to-metal contact.
- After assembly and inspection and before backfilling, coat exterior surfaces of buried couplings, including bolts and nuts, with heavy-bodied bituminous mastic.

G. Tapped Connection:

- Drill and tap normal to longitudinal axis.
- Drilled by skilled mechanics using proper tools.
- Use only tapered threads.

H. Electrical Conductors:

- Install pipes so terminal strips are aligned.
- Install jumper strips and tighten bolts.

3.05 TESTING:

- A. Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.
- B. Pressure and Leakage Tests:
 - 1. Conduct combined pressure and leakage test:
 - a. Initially on pipeline between first two valves, maximum length 1/4 mile, and within three days of completion.
 - b. Afterwards on completed sections of maximum length 1/2 mile.
 - c. Isolated sections upon completion.
 - 2. Conduct combined pressure and leakage test in pipelines.
 - 3. Furnish and install temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.
 - 4. Test when desired and comply with specifications.
 - 5. Test pipelines in excavation or embedded in concrete before backfill or placing of concrete and test exposed piping before field painting.
 - 6. Fill section of pipe with water and expel air. If hydrants or blowoffs are not available at high points for releasing air, make necessary taps and plug after test completion.
 - 7. Maintain section full of water for 24 hours before conducting combined pressure and leakage test.
 - 8. Conduct pressure and leakage test consisting of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to pipe pressure rating, but not more than 150 psi.
 - 9. Maintain pressure and make leakage test by metering water flow into pipe.
Acceptable results:
 - a. Average leakage during test: less than 10 gallons per inch of diameter per 24 hours per mile.
 - b. No visible leakage in joints.

10. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section fails test.
11. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.
12. Modify test procedure only if permitted by Engineer.

3.06 DISINFECTING AND FLUSHING:

- A. Disinfect potable water lines using procedures and materials conforming to AWWA C651.
- B. Dosage to produce minimum 10 ppm after minimum of 24 hour contact period.
- C. After treatment, flush with clean water until residual chlorine content less than 0.2 ppm.
- D. Prevent contamination of water in existing water mains. Neutralize chlorine content of water used in disinfecting and flushing accordance with AWWA C651.

3.07 PAINTING:

- A. Field painting, Section 09941.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and remove all formwork to produce cast-in-place concrete structures as indicated and specified. The use of stay in place forms is expressly prohibited.
- B. Use formwork to cast all concrete structures including foundation mats, base slabs, footings, slabs on grade, grade beams and pile caps.
- C. Provide and remove all formwork for electrical work as indicated or specified under electrical work.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Section 03200: Concrete Reinforcement
- C. Section 03300: Cast-In-Place Concrete

1.03 REFERENCES:

- A. American Concrete Institute (ACI):
 - 1. ACI 117: Standard Tolerances for Concrete Construction and Materials
 - 2. ACI 301: Standard Specifications for Structural Concrete
 - 3. ACI 347R: Guide to Formwork for Concrete
- B. Department of Commerce (DOC):
 - 1. DOC PS 1: Construction and Industrial Plywood
- C. National Sanitation Foundation (NSF):

1.04 SUBMITTALS:

- A. Shop Drawings: Submit the following manufacturer's data and literature in accordance with Section 01300 - SUBMITTALS:
 - 1. Form ties.
 - 2. Form releasing agents.
 - 3. Tubular fiber forms.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 – QUALITY ASSURANCE and as specified herein.
- B. Produce shop drawings indicating details of form type, methods of form construction and erection and the location of form joints, pipe penetrations, form ties and shoring. Maintain a copy of the drawings in the field office during form erection.
- C. Design and construct formwork in conformance with methodology of ACI 347R and as specified herein. Provide the following minimum surface finishes as defined in ACI 347:
 - 1. Surfaces exposed to view or exposed to liquids shall have a Class A formed surface with a maximum irregularity of 1/8" [3 mm] in 5 feet [1.5 meters].
 - 2. Surfaces to receive plaster, stucco or shotcrete shall have a Class B formed surface with a maximum irregularity of 1/4" [6 mm] in 5 feet [1.5 meters].
 - 3. All other surfaces shall have a Class C formed surface with a maximum irregularity of 1/2" [13 mm] in 5 feet [1.5 meters].
 - 4. Class D surfaces are unacceptable for any concrete work.
- D. Comply with the requirements in ACI 117 for tolerances for formed surfaces except as specified in Table 03100-1.
- E. Check vertical and horizontal alignment of formwork before placing concrete. Adjust formwork to maintain the concrete tolerances specified.
- F. Notify the Engineer a minimum of forty-eight (48) hours before the closure of forms that would hinder subsequent inspection to enable the engineer to inspect the Work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Formwork Design Requirements:

1. Design formwork in conformance with methodology of ACI 347R for anticipated loads, lateral pressures, depth of concrete placement and rate of concrete placement.
2. Locate bracing and shoring to maintain form stability and comply with finish tolerances specified.
3. Provide drop chutes and/or drop pipes to prevent accumulation of hardened concrete on forms and reinforcement above fresh concrete and to prevent concrete segregation.
4. Construct forms with regard for construction and expansion joint locations and architectural lines.
5. Use panels as large as practical to minimize form seam lines.
6. Construct forms to minimize fines leakage during concrete placement at construction joints, bulkheads, base of wall/slab intersections and other areas where fines may migrate from the concrete surface during placement. The level of acceptable fine leakage from the formed surface shall be determined by the Engineer as evidenced by the lack of rock pockets formed during placement of the concrete.

B. Formwork Construction:

1. Provide material for forms that is not reactive with concrete. Formwork of aluminum is not acceptable.
2. Expandable metal mesh shall not be used in formwork.
3. Provide material which will produce surfaces equivalent in smoothness and appearance to that produced by new plywood panels conforming to DOC PS 1, Exterior Type, Grade B-B.
4. Provide forms which will not deflect beyond finish tolerances specified.

C. Form Ties:

1. Provide factory fabricated, metal ties that will prevent form deflection beyond finish tolerances specified and will not spall concrete upon tie removal. Provide

solid backing at each tie.

2. Provide ties fitted with devices that will form cone shape holes in concrete surface not less than 3/8 inch [10 mm] interior diameter or more than 1-1/4 inch [32 mm] in exterior surface diameter and at least 1-1/2 inch [38 mm] deep such that the portion of the tie remaining in the concrete will be at least 1-1/2 [38 mm] inch back from concrete surface
3. Provide ties with waterstop devices to break surface continuity around ties and inhibit water seepage.

D. Form Releasing Agents:

1. Provide form releasing agents of commercial formulations that will not bond with, stain or adversely affect concrete surfaces.
2. Form releasing agents must not impair subsequent treatment of concrete surfaces that depend upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.
3. Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon [250 grams per liter] or that as acceptable in the State, County, or District of their intended use, whichever is more stringent.

E. Chamfer Strips:

1. Provide three-quarter inch triangular fillets to form all exposed concrete corners.
2. Material shall be milled clear straight-grain pine, surfaced each side or extruded vinyl.

PART 3 - EXECUTION

3.01 COATING:

- A. Coat forms with a form releasing agent before the forms and reinforcement are placed in their final position. Do not allow coating to come in contact with reinforcement, waterstops, construction or expansion joints. Apply coating as recommended in the manufacturer's printed instructions.
- B. Remove surplus coating on form surfaces before placing concrete.
- C. Do not allow excess coating material to stand in puddles in the forms or come in contact with concrete against which fresh concrete is to be placed.

3.02 INSTALLATION:

- A. Erect forms as designed and in accordance with the shop drawings.
- B. Erect forms butted tightly together to prevent mortar leakage.
- C. Where forms for continuous surfaces are placed in successive units, fit the forms over the existing surface so as to obtain accurate alignment of the surface and to prevent mortar leakage.
- D. Arrange joints between formwork panels vertically and horizontally to match construction and expansion joint locations and architectural lines.
- E. Set forms true to the indicated line and grade and to obtain the specified tolerances for formed surfaces. Correct deviations before concrete placement.
- F. Correct deviations in lines and grades after concrete placement to the extent of demolishing and rebuilding concrete structures at no additional cost to the Owner.
- G. Control grade of finished surfaces and horizontal construction and expansion joints by setting chamfer strips or grading strips true to grade.
- H. Inspect forms, embedded items and foundation preparation before placing concrete. Remove all snow, ice, water, dirt, debris and foreign matter from excavation and within formwork before placing concrete.
- I. Protect materials in construction and expansion joints from damage during construction.
- J. Key groove construction joints as specified in Section 03250 – CONSTRUCTION AND EXPANSION JOINTS whether shown as keyed on the drawings or not. Horizontal construction joints in walls and the joint between the base of walls and the foundation need not be keyed unless indicated as such on the drawings.

3.03 REMOVAL:

- A. Remove forms and falsework in a manner that will prevent damage to the concrete and not impair the safety of the structure.
- B. Do not use pinch bars or similar tools to pry against concrete surfaces.
- C. Do not remove forms until concrete has aged as follows:
 - 1. Elevated slabs and beams: 7 days minimum.
 - 2. Walls, construction and expansion joint bulkheads and other vertical surfaces: 24 hours minimum.

- D. Elevated slabs and beams shall have attained at least 70 percent of the specified 28 day strength before form removal. Concrete shall also have sufficient strength to safely support its own weight and construction loads. Determine concrete strength for form removal in conformance with ACI 301.
- E. Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28 day design strength.
- F. Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live load of the elements.

3.04 REUSE:

- A. Clean and repair the surfaces of forms that are to be reused to obtain the specified concrete finish. Withdraw all projecting nails and fill holes before reusing form material.
- B. Do not reuse forms if there is any evidence of surface wear and tear, splits, fraying, delaminating or other damage which would impair the quality of the concrete surface or prevent obtaining the specified concrete finish.
- C. When forms are extended for successive concrete placements, thoroughly clean form surfaces of mortar from previous concreting and of all other foreign material before reuse.
- D. Apply new form releasing agent to all form areas which will be in contact with concrete.

3.05 TOLERANCES:

- A. Comply with the requirements of ACI 117 for tolerances for formed surfaces except as specified in Table 03100-1.

TABLE 03100-1 TOLERANCES FOR FORMED SURFACES	
1. Vertical alignment (plumbness)	1/4" [6 mm] in any 10 [3 meters] feet and 1" [25 mm] maximum for entire length
2. Variation in the lines and surfaces of foundation mats, base slabs and walls	1/4" [6 mm] in any 10 [3 meters] feet and 1" [25 mm] max. for entire length
3. Variation from the level or from the grades indicated on the drawings	1/4" [6 mm] in any 10 [3 meters] feet
4. Variation of the linear building lines from established position in plan	1/2" [13 mm] in any 20 feet [6 meters] and 1" [25 mm] maximum for entire length
5. Variation of distance between walls	1/4" [6 mm] in any 10 [3 meters] feet and 1" [25 mm] maximum for entire length and height
6. Variation in the sizes and locations of sleeves, floor openings and wall openings	Minus 1/4" [6 mm]. Plus 1/2" [13 mm].
7. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4" [6 mm]. Plus 1/2" [13 mm].
8. Offset between adjacent panels of formwork facing material	1/2" [13 mm] (ACI 117 Class C finish).
9. Offset between adjacent panels of formwork facing material for exposed surfaces where appearance is of importance	1/8" [13 mm] (ACI 117 Class A finish).

NOTE: Tolerances are not cumulative

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01700 – CONTRACT CLOSEOUT.

END OF SECTION

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide reinforcement and accessories as indicated and specified.
- B. Provide and set reinforcement and accessories for electrical work as indicated and specified under electrical work.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Section 03100: Concrete Formwork
- C. Section 03300: Cast-in-Place Concrete

1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. A 185: Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 2. A 615/A 615M: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 3. A 706/A 706M: Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement

B. American Concrete Institute (ACI):

1. ACI SP-66: ACI Detailing Manual
2. ACI 318: Building Code Requirements for Structural Concrete and Commentary

C. American Welding Society (AWS):

1. AWS D1.4: American Welding Society, Structural Welding Code, Reinforcing Steel

1.03 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTALS:

1. Mill test reports for each shipment of reinforcement. Identify reports with specific lots in shipment and submit prior to use of reinforcement in work.
2. Chemical composition of reinforcement steel. Ladle analysis indicating percentage of carbon, phosphorous, manganese and sulfur present in steel.
3. Current welder's certification in conformance with AWS D1.4 for the appropriate electrode and class of material, when welding is indicated or specified. Testing shall be conducted and witnessed by an independent testing laboratory prior to welding reinforcement in work. Maintain qualification and certification records at the job site, readily available for examination of test results.
4. Shop and placement drawings for all reinforced concrete and masonry structures shall be approved by Engineer prior to fabrication which indicate:
 - a. All construction and expansion joints.
 - b. Reinforcement detailed in conformance with ACI SP-66.
 - c. Support bars and details of reinforcing bar supports including type, size and spacing.
 - d. Marking for each reinforcement item.
5. Locations of reinforcing bar cut-offs, splices and development lengths.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 – QUALITY ASSURANCE and as specified herein.
- B. Do not fabricate reinforcement until shop and placement drawings have been approved by the Engineer.
- C. Remove reinforcement with kinks or bends not shown on approved shop or placement drawings. Remove all such reinforcement from job site and replace with new fabricated steel. Field bending of reinforcement is prohibited unless reinforcement is indicated or specified to be field bent.
- D. Set reinforcement to tolerances specified in ACI 318, except the tolerance on minimum concrete cover shall be minus 1/4 inch.
- E. Perform welding indicated or specified in conformance with the requirements of AWS D1.4 for procedures and welding.
- F. All welding shall be performed by qualified operators in conformance with requirements of AWS D1.4. Welders shall be certified by test to perform type of work required within the 12 months immediately prior to welding.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in conformance with Section 01610 - DELIVERY, STORAGE AND HANDLING and as specified herein.
- B. Deliver reinforcement and accessories to work site with items of same size and shape fastened in bundles that are clearly marked with identification tags indicating size and mark.
- C. Store reinforcement and accessories off the ground on a platform or skids and protect from snow, rain and ground splatter.
- D. Protect reinforcement from rusting, deforming, bending, kinking and other injury. In-place reinforcing which has rusted, or been splattered with concrete shall be cleaned via sand or water blasting to the satisfaction of the Engineer prior to incorporation into the Work.

PART 2 - PRODUCTS

2.01 STEEL REINFORCING BARS:

- A. Provide newly rolled deformed billet-steel reinforcement bars conforming to ASTM A 615, Grade 60.
- B. Provide weldable deformed reinforcement conforming to ASTM A 706, Grade 60, when welding is indicated or specified.

2.02 TIE WIRE:

- A. Provide minimum 16 gage mild steel or annealed iron tie wire for uncoated reinforcement.

2.03 REINFORCING BAR SUPPORTS:

- A. Provide minimum size number 5 support bars.
- B. Provide plastic protected reinforcing bar supports in contact with exposed surfaces in conformance with ACI SP-66.
- C. Provide 3-in. [75 mm] by 3-in. [75 mm] plain precast concrete blocks, precast concrete doweled blocks or concrete brick for support of bottom reinforcing in foundation mats, base slabs, footings, pile caps, grade beams and slabs on grade. Provide block thickness to produce concrete cover of reinforcement as indicated.

2.04 WELDED WIRE FABRIC:

- A. Provide welded wire fabric reinforcement conforming to ASTM A 185.
- B. Provide welded wire fabric in flat sheets.
- C. Provide support bars and reinforcing bar supports as specified herein to obtain the concrete cover indicated.

PART 3 - EXECUTION

3.01 PLACEMENT:

- A. Clean all reinforcement and accessories of mortar, oil, dirt, loose mill scale, loose or thick rust and coatings of any character which will reduce bond with concrete before setting in forms to the satisfaction of the Engineer.
- B. Set reinforcing bars and welded wire fabric to tolerances specified in ACI 318, except tolerance for minimum concrete cover shall be minus ¼ inch. Secure reinforcing in

position using tie wire with ends pointed away from forms and finished grade lines and is subjected to the same clearance tolerances as the reinforcing bars.

- C. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits or embedded items providing the same reinforcing coverage is maintained. Bars moved more than three inches, or bars moved to a greater or lesser depth of coverage are subject to approval of the Engineer.
- D. Position dowels accurately. Rigidly support, align and securely tie dowels normal to the concrete surface before concrete placement. Setting dowels into wet concrete is prohibited.
- E. Provide and place safety caps on all exposed ends of vertical reinforcement that pose a danger to life safety.
- F. Use chairs, bolsters and spacers of sufficient strength to resist crushing under load to hold reinforcing bars and welded wire fabric in place in conformance with ACI SP-66.
- G. Do not use metal chairs, ferrous clips, nails, etc. which extend to the surfaces of the concrete. Do not use stones, brick or wood block supports.
- H. Use precast concrete reinforcing bar support blocks or concrete brick for foundation mats, base slabs, footings, pile caps, grade beams and slabs on grade.
- I. Setting bars and welded wire fabric reinforcement on layers of fresh concrete as the work progresses or adjusting reinforcement during the placement of concrete is prohibited.
- J. Set bars in contact and tie securely at reinforcement lap splices or space transversely apart to permit embedment of entire surface of each bar in concrete. Length of lap splices for reinforcement shall conform to the requirements of ACI 318, unless otherwise indicated or specified.
- K. Tie a minimum of 25 percent of all intersecting bars in foundation mats, base slabs, footings, pile caps, slabs on grade and elevated slabs.
- L. Do not splice reinforcement steel in foundation mats, base slabs, beams, girders, slabs and walls at points of maximum stress unless otherwise indicated. The Engineer shall be consulted on all bar splice locations not shown on the drawings. Shop drawings shall specifically flag splice locations that do not show on the drawings.
- M. Lap splice welded wire fabric reinforcement at least two full meshes. Stagger splices to avoid continuous laps in either direction and wire tightly together.
- N. Provide continuous reinforcement through construction joints.

- O. Do not use continuous reinforcement or other fixed metal items through expansion joints. Provide two-inch reinforcement clearance from each face of expansion joint.
- P. Do not use heat to bend or straighten reinforcing steel.
- Q. Welding of reinforcing bars is permitted only where indicated or specified. Perform all welding in accordance with AWS D1.4.
- R. Welding of reinforcing steel shall be performed only by operators certified by test in conformance with AWS D1.4 and as specified herein.
- S. Tack welding reinforcement is prohibited.

3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700 – CONTRACT CLOSEOUT.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide, finish, protect, and cure cast-in-place concrete as indicated and specified.
- B. Provide, finish, protect and cure cast-in-place concrete indicated and specified under electrical work.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Section 03100: Concrete Formwork
- C. Section 03200: Concrete Reinforcement
- D. Section 03345: Concrete Floor Treatment

1.03 REFERENCES:

- A. American Concrete Institute (ACI):
 - 1. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - 2. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete
 - 3. ACI 301: Standard Specifications for Structural Concrete
 - 4. ACI 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
 - 5. ACI 305R: Hot Weather Concreting
 - 6. ACI 306R: Cold Weather Concreting
 - 7. ACI 308: Standard Practice for Curing Concrete
 - 8. ACI 309R: Guide for Consolidation of Concrete

9. ACI 311.4R: Guide for Concrete Inspection
10. ACI 318: Building Code Requirements for Structural Concrete
11. ACI 350: Code Requirements For Environmental Engineering Concrete Structures

B. American Society for Testing and Materials (ASTM) Publications:

1. A 123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. A 153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. C 31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
4. C 33: Standard Specification for Concrete Aggregates
5. C 39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
6. C 40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
7. C 42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
8. C 87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
9. C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
10. C 94: Standard Specification for Ready-Mixed Concrete
11. C 109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50-mm] Cube Specimens)
12. C 123: Standard Test Method for Lightweight Particles in Aggregate
13. C 136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
14. C 138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

15. C 143: Standard Test Method for Slump of Hydraulic Cement Concrete
16. C 150: Standard Specification for Portland Cement
17. C157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete
18. C 171: Standard Specification for Sheet Materials for Curing Concrete
19. C 172: Standard Practice for Sampling Freshly Mixed Concrete
20. C 192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
21. C 231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. C 260: Standard Specification for Air-Entraining Admixtures for Concrete
23. C 289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
24. C 295: Standard Guide for Petrographic Examination of Aggregates for Concrete
25. C 309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
26. C 311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
27. C 494: Standard Specification for Chemical Admixtures for Concrete
28. C 595: Standard Specification for Blended Hydraulic Cements
29. C 618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
30. C 882: Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear
31. C 989: Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
32. C 1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

33. C 1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
34. C 1116: Standard Specification for Fiber Reinforced Concrete
35. C 1240: Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
36. D 75: Standard Practice for Sampling Aggregates
37. E 154: Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
38. E 329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

C. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M182:

1.04 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTALS:

1. Name and address of proposed Contractor's testing laboratory firm and a brief description of prior work which is similar to that proposed for this project. Provide prior work owner's full name, address and telephone number. ASTM E 329 will also be used as one of the basis for evaluating the testing laboratory firm.
2. Concrete design mixes and results of strength tests from trial concrete mixes by the Contractor's testing laboratory firm.
3. Material test results by the Contractor's testing laboratory:
 - a. Fineness modulus of fine aggregate per ASTM C 136.
 - b. Fine aggregate organic impurities per ASTM C 40.
 - c. Fine aggregate mortar strength per ASTM C 87 and ASTM C 109.
 - d. Quality of fine and coarse aggregates per ASTM C 33.
 - e. Quality of the cement per ASTM C150.

- B. Mill test reports for each shipment of cement, regardless of quantity, prior to incorporation into the work.
- C. Manufacturer's specifications and instructions for all admixtures, curing materials, adjustable inserts and non-shrink non-metallic grout. Manufacturer's certification of compatibility of all admixtures.
- D. For concrete vaults, provide Certificate of Design and sign and sealed drawing by a Florida Registered Professional Engineer retained by the Contractor.

1.05 QUALITY ASSURANCE:

- A. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the work.
- B. Perform concrete work in conformance with ACI-301 unless otherwise indicated or specified.
- C. Do not use admixtures, including calcium chloride, which will cause accelerated setting of cement in concrete.
- D. Do not place concrete until design mix, material tests and trial concrete batch mix compression test results are approved by the Engineer. Approvals are required at least 30 days before placing any production concrete.
- E. The Contractor shall employ an independent testing laboratory, acceptable to the Engineer, to test conformity of materials to specifications and to design concrete mixes. Concrete testing shall be performed by and an ACI Concrete Field Technician, Grade I or equivalent.
- F. Furnish, pay for and deliver representative samples of sufficient quantity of cement, aggregates and admixtures required for trial concrete batch mixes to the testing laboratory. Obtain materials from the concrete batching plant that will be supplying production concrete in conformance with ASTM D 75.
- G. Testing laboratory shall furnish trial concrete design mixes having proportions, admixtures and slump proposed for use, based upon ACI 211.1. Furnish at least three different water-cement ratios that will produce a range of strengths, aggregate sizes and admixture combinations encompassing those required for the work. Report design mixes for maximum permitted air, slump and temperature of concrete used in trial batches.
- H. Produce new concrete design mixes at no additional cost to the Owner when job site concrete is not of required strength. Provide additional testing when original sample materials produce unsatisfactory results or new material sources are to be used. All additional testing shall be done by the same testing laboratory and paid for by the Contractor.

- I. Measure all materials for concrete, including water, with equipment and facilities suitable for accurate measurement and capable of being adjusted in conformance with ASTM C 94. Use scales certified by local Sealer of Weights and Measures within one year of use and accurate when static load tested to plus or minus 0.4 percent of total capacity of scale. Batch all materials by weight except admixtures that may be batched by volume.
- J. Once the mix design is approved, the contents of the mix ingredients shall not be altered from the approved materials (volume, location, type, size, etc...). Batch tickets shall indicate the amount of material batched for each material. Material batched that is not within the allowable tolerances shall be cause for rejection.
- K. The Owner's testing agency will take control test specimens; conduct slump tests and measure air content and temperature in the field.
- L. Methods of Sampling and Testing:
 - 1. Fresh Concrete Sampling: ASTM C 172
 - 2. Specimen Preparation: ASTM C 31
 - 3. Compressive Strength: ASTM C 39
 - 4. Air Content: ASTM C 231
 - 5. Slump: ASTM C 143
 - 6. Temperature: ASTM C 1064
 - 7. Unit Weight: ASTM C 138
 - 8. Obtaining Drilled Cores: ASTM C 42
 - 9. Drying Shrinkage: ASTM C 157
- M. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.
- N. Hot weather concrete to conform to ACI 305R and as specified herein.
- O. Cold weather concrete to conform to ACI 306R and as specified herein.
- P. Reject concrete delivered to job site that exceeds the time limit specified.

Q. Reject concrete delivered to job site that exceeds the concrete temperature limitations specified.

R. Do not place concrete in water or on frozen or uncompacted ground.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in conformance with Section 01610 – DELIVERY STORAGE AND HANDLING and as specified herein.

B. Order concrete from batching plant so that trucks arrive at discharge locations when concrete is required. Avoid excessive mixing of concrete or delays in placing successive layers of concrete in forms. Re-tempering of concrete is strictly prohibited.

C. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

D. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

1.07 JOBSITE CONDITIONS:

A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C 31 and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Furnish Portland cement conforming to ASTM C 150. Use one approved brand from one mill throughout the contract term unless otherwise approved by the Engineer. Use cement of uniform color.

1. Use Type II for all work, unless otherwise indicated or specified.

2. Reject the entire shipment when cement is lumpy, wetted, partially or wholly set.

B. Water:

1. Use water for concrete that is potable and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances, conforms to the requirements for water in ASTM C 94, and as specified herein.
2. The maximum water-soluble chloride ion in the water shall not exceed 0.060 percent by weight of cement.
3. Heat or cool water to obtain concrete temperatures indicated or specified, and in conformance with ACI 305R and ACI 306R.

C. Aggregates:

1. Use fine aggregates for normal weight concrete consisting of well graded natural sand from a single source conforming to ASTM C 33 and to the following requirements:
 - a. Fineness modulus: 2.50 to 3.10
 - b. Organic impurities: Color intensity not darker than 2/3 standard color solutions, nor darker than Organic Plate No. 2, determined by ASTM C 40.
 - c. Soundness: Maximum of 10 percent weighted average loss after 5 cycles of magnesium sulfate soundness test as determined by ASTM C 88.

D. Use coarse aggregates from a single source for normal weight concrete consisting of washed, well graded gravel or crushed stone conforming to ASTM C 33 and to the following requirements:

1. Soundness: Maximum of 14 percent weighted average loss after 5 cycles of magnesium sulfate soundness test as determined by ASTM C 88.
2. Test aggregates for chert in conformance with ASTM C 33 as determined by ASTM C 123.
3. Test conformity of aggregate and confirm that aggregates intended for use in concrete are potentially non-reactive when tested in conformance with ASTM C 289.

E. Admixtures:

1. General Requirements:

- a. Maintain compressive strength and maximum water-cement ratios indicated in Table 03300-1 when using admixtures. Include all admixtures in solution form in the water-cement ratio calculations.
 - b. Do not use calcium chloride, admixtures containing chloride ions or other admixtures causing accelerated setting of cement. Do not use combinations of admixtures and cements producing erratic or otherwise undesirable results with aggregates.
 - c. Reject admixtures that have been in storage for longer than manufacturer's recommendations or which have been subjected to freezing.
 - d. Do not use admixtures in greater dosages than recommended by manufacturer.
 - e. The strength of concrete with proposed admixtures after 48 hours shall not be less than the strength of similar concrete without admixture.
 - f. All admixtures shall be obtained from one manufacturer. The manufacturer shall be capable of providing qualified field service representation.
 - g. Admixtures shall be used in compliance with the manufacturer's printed instructions. The manufacturer shall certify the compatibility of multiple admixtures used in the same mix.
2. Air-Entrainment:
- a. Air entrain all concrete. Use admixtures conforming to ASTM C 260.
 - b. Provide total air content by volume in field mixtures of normal weight concrete:

5 ± 1½ percent for concrete using 1-1/2 inch [38 mm] maximum aggregate size.

6 ± 1½ percent for concrete using 3/4 inch [19 mm] maximum aggregate size.
 - c. Measure air content in accordance with ASTM C 231.
 - d. Adjust the admixture content to accommodate the fly ash or pozzolan requirements, and other admixtures when used, in order to obtain the specified air content.
3. Mid-Range Water Reducer: Use admixture conforming to ASTM C 494, Type A.

4. High Range Water Reducer (Super Plasticizer): Use admixture conforming to ASTM C 494, Type F, extended slump life.
- F. Curing Compound: Liquid form, which will form impervious membrane over, exposed surface of concrete when applied to fresh concrete by means of spray gun. Compound shall not inhibit future bond of floor covering or concrete floor treatment. Use Type I-D compound with red fugitive dye, Class B, having 18 percent minimum solids conforming to ASTM C 309.
- G. Evaporation Retardant shall be:
1. Confilm as manufactured by Master Builders.
 2. Eucobar as manufactured by Euclid Chemical Company
 3. SikaFilm as manufactured by Sika Corporation
 4. Or equal.
- H. Waterproof Curing Sheet: Waterproof paper polyethylene film or white burlap-polyethylene film conforming to ASTM C 171.
- I. Cloth, Burlap, Jute or Kenaf: Curing materials conforming to AASHTO M182.
- J. Curing mats shall be heavy carpets or cotton mats, quilted at 4 inches on center. Curing mats shall weight a minimum of 12 ounces per square yard when dry.
- K. Adjustable Inserts: Adjustable inserts shall be hot-dip galvanized in conformance with ASTM A 123 and A 153. Adjustable inserts shall be:
1. Ductile iron wedge inserts, Type F-7 manufactured by The Dayton Sure-Grip & Shore Co.
 2. Malleable iron wedge inserts, Type HW manufactured by Hohmann & Barnard Inc.
 3. Malleable iron peerless wedge inserts manufactured by Richmond Screw Anchor Co., Inc.
 4. Or equal.
- L. Non-shrink, Non-metallic Grout: Commercial formulation requiring only addition of water with minimum 28-day compressive strength of 5,000 psi conforming to ASTM C 1107, Grade A, B or C. Grout shall be:

1. Five Star grout manufactured by U.S. Grout Corp.
2. SikaGrout 212 manufactured by Sika Corporation.
3. Masterflow 928 Grout manufactured by Master Builders
4. Or equal.

2.02 MIXES:

- A. Use ready-mixed, air-entrained concrete secured from a batching or mixing plant conforming to ASTM C 94 capable of developing specified characteristics and being placed without segregation.
- B. Concrete Strengths:
 - 1. Use 4,000 psi [28 MPa] concrete for all work unless otherwise indicated or specified.
 - 2. Use 4,500 psi [31 MPa] concrete for all liquid containment structures unless otherwise indicated or specified.
 - 3. Use 4,000 psi [28 MPa] fiber reinforced concrete for all concrete fills and toppings, unless otherwise indicated or specified.
 - 4. Use 1,500 psi [10 MPa] concrete for concrete under foundations or whenever low strength concrete is indicated, specified or permitted by the Engineer.
- C. Secure, for every part of work, concrete of homogeneous structure having required strength, water tightness, and durability.
- D. Use the following coarse aggregate sizes for concrete:
 - 1. 1-½ inches [38 mm] for walls greater than 30 inches [750mm] in thickness, grade beams, footings, foundation mats, and base slabs.
 - 2. ¾ inches [19 mm] for all other concrete.
 - 3. ⅜ inches [10 mm] in congested areas where approved by the engineer and for fireproofing around structural steel beams and columns and to fill cored holes.
- E. Provide concrete meeting the requirements in Table 03300-1.

TABLE 03300-1		
Minimum compressive strength at 28 days (psi)	Minimum compressive strength at 28 days (MPa)	Maximum water cement ratio*
1,500	10	0.76
3,000	20	0.53
4,000	28	0.45
4,500	31	0.42
5,000	35	0.40
5,500	38	0.39

*Total water in mix at time of mixing, including free water in the aggregates and liquid admixtures.

- F. Consistency: Mix concrete to produce homogeneous consistency, capable of being worked into constricted areas of forms, corners and around embedded items, without segregation or bleeding of free water.
- G. Fly ash or pozzolan shall not exceed 15 percent of the combined weight of fly ash, pozzolan or ground granulated blast-furnace slag and cement.
- H. Use silica fume concrete where indicated on the drawings. Silica fume not to exceed 10 percent of the total weight of the silica fume plus cement.
- I. Concrete Slump: Provide concrete with a maximum slump of 4 inches. Provide concrete using water reducing admixtures with a maximum slump of 4 inches before addition of the water reducer and a maximum slump of 6 inches after the addition of a mid-range water reducer or a maximum slump of 8 inches after the addition of a high range water reducer. Determine concrete slump in conformance with ASTM C 143.

2.03 CONCRETE TOLERANCES:

- A. Conform to the requirements specified in Section 03100 – CONCRETE FORMWORK for finish tolerances for formed surfaces.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Batch, mix and deliver Portland cement concrete in conformance with ASTM C 94. Batch all constituents at a central batching or mixing plant. Produce concrete in conformance with ACI 301 and as specified herein.
- B. Seasonal Conditions:
 - 1. Conform to ACI 305R and as specified herein for hot weather concreting. Do not add retarder admixture to any concrete.

3.02 FORMS:

- A. Provide and remove all formwork as specified in Section 03100 – CONCRETE FORMWORK.

3.03 JOINTS AND EMBEDDED ITEMS:

A. Embedded Items:

1. Clean embedded items of oil and all foreign matter.
2. Install inserts, anchors, sleeves and other items into formwork where indicated or specified under other sections of these specifications.
3. Aluminum items shall not be embedded in concrete.
4. Complete required tests on embedded piping before starting concrete placement.
5. Check location and support of piping, electrical conduits and other embedded items before depositing concrete. Correct locations as required and secure in place.

B. Embedded Pipes And Conduit:

1. Embedded pipes and conduit in concrete shall conform to the requirements and limitations of ACI 318, ACI 350 and these specifications and shall be as approved by the engineer.
2. Conduits, pipes, and sleeves of any material not harmful to concrete and within the limitations specified herein shall be permitted to be embedded in concrete with the approval of the Engineer.
3. Conduits, pipes and sleeves of aluminum shall not be embedded in concrete.
4. Pipes passing through walls of a liquid-containing structure shall include an integral waterstop.
5. Conduits, pipes, and sleeves passing through a slab, wall, or beam shall not impair significantly the strength of the construction.
6. Conduits and pipes, with their fittings, embedded within a column shall not displace more than 4 percent of the area of cross section.
7. Except when drawings for conduits and pipes are approved by the structural engineer, conduits and pipes embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:

- a. Conduits and pipes shall not be larger in outside dimension than $\frac{1}{3}$ the overall thickness of the slab, wall, or beam in which they are embedded.
 - b. Conduits and pipes shall not be spaced closer than 3 times the outside diameters on center.
 - c. Conduits and pipes shall be placed within the middle third of the element and between reinforcement layers. Do not install runs of piping or conduit between formwork and reinforcement.
 - d. Avoid crossing pipes and conduit in concrete.
- 8. Pipes and fittings shall be designed to resist the effects of the material, pressure, and temperature to which they will be subjected.
 - 9. No liquid, gas, or vapor, except water not exceeding 90 F or 50 psi pressure, shall be placed in the pipes until the concrete has attained its design strength.
 - 10. Reinforcement with an area not less than 0.002 times area of concrete section shall be provided perpendicular to piping or conduit at a maximum spacing of 12 inches [300 mm].
 - 11. Piping and conduit shall be so fabricated and installed that cutting, bending, or displacement of reinforcement from its proper location will not be required.
 - 12. Close ends of conduits, piping and sleeves embedded in concrete with caps or plugs prior to concrete placement.

3.04 TRANSPORTING AND MIXING:

- A. General: Conform to concreting procedures set forth in ACI 304R and as specified herein.
 - 1. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.
 - 2. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first. Do not add water at the jobsite, nor exceed the maximum water content in the approved concrete design mix.
 - 3. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time is necessary, in conformance with the following:

- a. Reduce maximum mixing and placement time from 90 to 45 minutes maximum when concrete temperature at time of placement is between 85 and 90 degrees Fahrenheit.
 - b. Reject concrete with a temperature in excess of 90 degrees Fahrenheit.
- B. Conveying: Convey concrete from agitator or mixer truck to place of final deposit in forms by one of the following methods:
 - 1. Buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to horizontal.
 - 2. Buggies or wheelbarrows equipped with pneumatic tires.
 - 3. Round bottom, metal or metal-lined chutes with inclined slope of between two to three feet horizontally to one foot vertically and of sufficient capacity to avoid overflow.
 - 4. Circular drop pipes with a top diameter of at least eight times the maximum aggregate size, but not less than 6 in. [150 mm], or tapered to not less than six times maximum aggregate size. Do not drop concrete more than 5 feet [1.5 meters] without drop pipes.

3.05 CONCRETE ACCEPTANCE:

- A. The Contractor shall accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. The signature of a Contractor's authorized representative on the delivery batch ticket shall indicate concrete acceptance.
- B. The Contractor shall reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the Contractor and Engineer.
- C. The Owner's testing agency shall perform field tests at the point of agitator or mixer truck discharge. Accept or reject concrete on the basis of conformity with slump, air content and temperature specified.
- D. The Owner's testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete which exceeds the maximum barrel revolution of 300 or which has water content exceeding the specified water-cement ratio.
- E. The Contractor shall reject concrete exceeding the time or temperature limitations specified.

- F. The Contractor shall reject concrete not conforming to specification before discharging into the forms.

3.06 PLACING:

- A. Intentionally roughen surfaces of set concrete in a manner to expose bonded aggregate uniformly at all joints where keys or keyways are not provided.
- B. Deposit concrete into its final position in conformance with ACI 304R and as specified herein. Place concrete in horizontal layers 1-1/2 to 2 feet [450 to 600 mm] thick maximum completely across forms. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.
 - 1. Do not deposit partially hardened concrete in forms. Retempering of partially hardened concrete is not permitted. Remove all partially hardened concrete from site at no additional compensation.
 - 2. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from mortar). Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.
 - 3. Do not splash forms and reinforcing above level of concrete being placed. Regulate placing of concrete so that pressure caused by wet concrete will not distort or deflect forms beyond finish tolerances specified in Section 03100 – CONCRETE FORMWORK or result in leakage of the cement paste.
- C. Pump Concrete:
 - 1. Use equipment and procedures and schedule deliveries to maintain steady flow of concrete at the discharge end of pipe.
 - 2. Maintain concrete properties of slump, air content and temperature. Make adjustments in concrete proportions as necessary to provide concrete properties in accordance with the approved concrete design mix and as specified herein.
 - 3. Do not pump concrete through aluminum piping.
 - 4. Use pipe having a diameter at least three times the maximum coarse aggregate size, but no less than 4 in.
 - 5. Take samples at the point of agitator or mixer truck discharge.
 - 6. Furnish labor and assistance as required by the testing laboratory in obtaining and handling test specimens.

D. Consolidation:

1. Consolidate concrete using mechanical vibrators operated within the mass of concrete and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.
2. Conduct vibration in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of sufficient amplitude to consolidate concrete. Use not less than one vibrator with crew for each 35 to 40 cubic yards [25 to 30 cubic meters] of concrete placed per hour.
3. Insert and withdraw vibrator vertically at a uniform spacing over the entire area of placement. Space distances between insertions such that spheres of influence of each insertion overlap.
4. Place concrete in horizontal lifts. Insert vibrator rapidly to bottom of layer, and at least six inches into underlying layer. Hold stationary for several seconds, and then withdraw at a rate of about 3 inches [75 mm] per second. Conduct vibration to produce concrete of uniform texture and appearance, free of honeycombing, streaking, cold joints or visible lift lines.

5. Use additional vibration with pencil vibrators on vertical surfaces and on all exposed concrete to bring full surface of mortar against the forms so as to eliminate air voids, bug holes and other surface defects. Employ the following additional procedures for vibrating concrete as necessary to maintain proper consolidation of concrete:
 - a. Reduce distance between internal vibration insertions and increase time for each insertion.
 - b. Insert vibrator as close to face of form as possible without contacting form or reinforcement.
 - c. Thoroughly vibrate area immediately adjacent to waterstops without damaging the waterstop.
 - d. Use spading as a supplement to vibration where particularly difficult conditions exist.

3.07 TESTING:

A. General:

1. The Owner's testing agency will use concrete samples provided by the Contractor at the point of agitator or mixer truck discharge to perform slump, air content, and temperature tests and for field control test specimens.

B. Notification of Delivery:

1. Notify the Engineer of concrete deliveries a minimum of 48 hours in advance of the scheduled placement. Include within this notification, the mix design and quantity of concrete, method and location of placement, frequency of trucks, ordered slump and time of initial delivery. The Contractor shall also notify the Owner's testing laboratory firm of scheduled concrete deliveries.
2. Place concrete during normal working hours whenever possible. Notify the Engineer of special conditions at least 48 hours in advance of placement when concrete placement schedules require concrete placement at times other than during normal working hours.
3. Furnish delivery batch ticket to the representative from the owner's testing laboratory or to the Engineer's representative in the field with each batch delivered to the discharge locations in conformance with ASTM C 94. Batch tickets shall be written in ink or computer printed. Batch tickets bearing any information written in pencil will be sufficient cause for rejection of the load.

4. Batch tickets shall include the following information:
 - a. Load number, truck number and driver's name
 - b. Strength of concrete (compression strength)
 - c. Amount of concrete (cu. yds. [cu. meters])
 - d. Time truck was charged with cement
 - e. Revolution counter reading at first addition of water
 - f. Type, brand and amount of cement
 - g. Type, brand and amount of admixtures
 - h. Information necessary to calculate total mixing water
 - i. Maximum size of aggregate
 - j. Weights of fine and coarse aggregates
 - k. Signature of ready-mix representative
 - l. Concrete temperature at batching plant
 - m. Type and amount of fly ash, pozzolan or ground granulated blast-furnace slag.

C. Test Measurements at Discharge:

1. The Owner's testing laboratory firm will take measurement of concrete slump, air content and temperature for each load of concrete. The laboratory firm will conduct the slump, air content and temperature test measurements in conformance with ASTM C 143, ASTM C 231, and ASTM C 1064, respectively.
2. The Owner's testing laboratory firm will submit test reports of concrete field measurements specified above to the Contractor and to the Engineer.

D. Control Test Specimens:

1. The Owner's testing laboratory firm will cast a minimum of one set of four field control test specimens in conformance with ASTM C 31 for each 50 cu. yd. [38 cu. meters] of each mix design of concrete but not less than once a day nor less than once for each 5,000 sq. ft. [450 sq. meters] of surface area of foundation mats, base slabs, footings, pile caps, slabs on grade, grade beams, walls, or elevated slabs.
2. Laboratory personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content and temperature.
3. The Contractor shall furnish tightly constructed 6 in. [150 mm] diameter by 12 in. [300 mm] long nonabsorbent test cylinder molds. Use molds of same type and manufacture for all test specimens. Leave molds on cylinders until received in testing laboratory.
4. The Contractor shall furnish boxes for initial curing of test cylinders in conformance with ASTM C 31 from time of fabrication until they are transported to the testing laboratory.
5. The Owner's testing agency will compression test one of each set of four specimens at seven days. Immediately notify the Contractor and the Engineer if the seven day strength is deficient. Test two of the remaining cylinders at twenty eight days for concrete strength acceptance. The acceptance test result is the average of the strengths of the two specimens tested at 28 days. The laboratory firm shall submit compression test results of the control test specimens to both the Contractor and the Engineer. The fourth cylinder shall be held for testing at 56 days only if the 28 day cylinder strengths are deficient. The fourth cylinder of each set shall be discarded if the 28 day strengths exceed the specified minimum.
6. The Contractor may take field control test specimens for small quantities of concrete only if approved by the Engineer.

E. Load Testing:

1. The Contractor will be directed by the Engineer to conduct a load test of the structure in conformance with ACI 318 under the direction of the Owner's testing firm should compression tests of concrete cores taken from the structure fail to be in compliance with ACI 301 and ACI 318.
2. The structure will be removed from the site and replaced should the load test fail. All costs associated with testing, removal and replacement of the structure will be borne by the Contractor at no additional cost to the Owner.

3.08 CURING AND PROTECTION:

A. General:

1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.
2. Comply with curing procedures set forth in ACI 301, ACI 308 and as specified herein.
3. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80 ° F [25° C] or above.
4. Perform cold weather concreting in conformance with ACI 306R and as specified herein when the ambient atmospheric temperature is 40 ° F [5 ° C] or below.
5. Concrete required to be moist cured shall remain moist for the entire duration of the cure. Repeated wetting and drying cycles of the curing process will not be allowed.

B. Duration:

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that wooden forms are kept continuously moist. Keep continuously moist for not less than 72 hours.
2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.
3. Avoid rapid drying at the end of the final curing period

C. Curing Requirements:

1. Unformed Surfaces: Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surface or as soon as marring of concrete will not occur. Protect finished slabs from direct rays of the sun to prevent checking, crazing and plastic shrinkage.
2. Formed Surfaces: Minimize moisture loss for formed surfaces exposed to heating by the sun by keeping forms wet until safely removed. Keep surface continuously

wet by warm water spray or warm water saturated fabric immediately following form removal.

3. Water containment and below Grade Structures: Moist cure by the application of water to maintain the surface in a continually wet condition. Use water that is free of impurities that could etch or discolor exposed concrete surfaces.
4. Other concrete: Moist cure by moisture-retaining cover curing, or by the use of curing compound. Use curing compound for water containment and below grade structures only in cold weather after the initial curing period or when approved by the engineer, in writing.

D. Curing Methods

1. Water Curing: Use warm water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:
 - a. Keeping the surface of the concrete continuously wet by ponding or immersion.
 - b. Continuous water-fog spray or sprinkling.
 - c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface, as necessary.
2. Sealing Materials:
 - a. Use common sealing materials such as plastic film or waterproofing (kraft) paper when approved by the Engineer.
 - b. Lap adjacent sheets a minimum of 12 inches [500 mm]. Seal edges with waterproof tape or adhesive. Use sheets of sufficient length to cover sides of concrete member.
 - c. Place sheet materials only on moist concrete surfaces. Wet concrete surface with fine warm water spray if the surface appears dry before placing sheet material.
 - d. The presence of moisture on concrete surfaces at all times during the prescribed curing period is proof of acceptable curing using sheet material.

3. Membrane Curing Compound:

- a. Apply membrane-curing compound uniformly over concrete surface by means of roller or spray at a rate recommended by the curing compound manufacturer, but not less than 1 gallon per 150 sq. ft. [1 liter per 4 sq. meters] of surface area. Agitate curing material in supply container immediately before transfer to distributor and thoroughly agitate it during application for uniform consistency and dispersion of pigment.
- b. When curing compound is authorized for application to liquid retaining or below grade members, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.
- c. Do not use curing compounds on construction and expansion joints or on surfaces to receive liquid hardener, dustproofer/sealer, concrete paint, tile, concrete fills and toppings or other applications requiring positive bond.
- d. Reapply membrane-curing compound to concrete surfaces that have been subjected to wetting within 3 hours after curing compound has been applied by method for initial application.
- e. Maintain the continuity of the coating and repair damage to the coating during the entire curing period.

E. Protection from environmental conditions: Maintain the concrete temperature above 50 degrees F [10 degrees C] continuously throughout the curing period. Make arrangements before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the curing period.

1. When the atmospheric temperature is 80 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering.
2. Protect the concrete continuously for the entire curing period.
3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes.
4. Avoid temperature changes in concrete that exceed 5 degrees F [3 degrees C] in any one hour and 50 degrees F [10 degrees C] in any 24-hour period.

- F. Protection from physical injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water. Do not load concrete in such a manner as to overstress concrete.
- G. Protection from Deicing Agents: Do not apply deicing chemicals to concrete.

3.9 REPAIR:

- A. General: Repair all surface defects immediately after form removal. Surface defects include tie holes, air voids and bug holes with a nominal diameter or depth greater than 1/4 inch [6 mm], honeycombed areas, visible construction joints, fins, burrs, color and texture variations and other defects as determined by the Engineer. Make concrete repairs in concrete surfaces to produce a uniform color and texture and free of all irregularities.
- B. Surface defects in all concrete surfaces that in the opinion of the engineer adversely affect the durability of the concrete shall be repaired per the requirements of this section. Such surface defects that require repair include all visible cracks in tank floors and walls and the exterior envelope of structures below grade, regardless of width; and cracks in all other areas in excess of 0.02-inch wide, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls.
- C. Repair of Cracks:
 - 1. Cracks, which have resulted from overstress conditions and are structural in nature, shall be pressure grouted using an injectable epoxy.
 - 2. Cracks in liquid retaining or below grade members, which have resulted from shrinkage stresses and show any sign of leakage, or are positioned such that leakage cannot be observed, shall be pressure grouted using a hydrophilic resin.
 - 3. Cracks in other members, which have resulted from shrinkage stresses and exceed 0.020 inch in width shall be pressure grouted using a hydrophilic resin.
 - 4. Apply crack repair materials in accordance with the manufacturer's directions and recommendations.
- D. Repair of Defective Areas:
 - 1. Remove rock pockets, honeycombed and other defective concrete down to sound concrete. Chisel edges a minimum of 1 inch [25 mm] deep perpendicular to the surface or slightly undercut. Do not feather edges.

2. Dampen the area to be patched and area at least 6 inches [150 mm] wide surrounding it for at least 24 hours to prevent absorption of water from patching mortar.
 3. Concrete repair material shall be a prepackaged polymer-modified cementitious repair mortar with the following minimum properties:
 - a. Compressive strength at one day: 2000 psi (ASTM C 109).
 - b. Compressive strength at 28 days: 6000 psi (ASTM C 109).
 - c. Bond strength at 28 days: 1800 psi (ASTM C 882 modified).
 4. Use no more mixing water than necessary for handling and placing. Mix patching mortar and allow to stand with frequent manipulation with a trowel, without addition of water, until it has reached stiffest consistency that will permit placing.
 5. Brush bond coat of neat cement well into surface after surface water has evaporated from area to be patched. Consolidate mortar into place and strike off so as to leave patch slightly higher than surrounding surface to permit initial shrinkage. Leave patch undisturbed for at least 1 hour before final finish. Keep patched area damp for a minimum of 7 days.
- E. Tie Holes: Fill tie holes solid with non-shrink, non-metallic patching mortar after cleaning and dampening.
- F. Core Holes: Roughen concrete surface, clean and dampen for at least 24 hours. Fill core holes with the specified repair mortar. Wet cure for 7 days after placement. Fill anchor holes completely with non-shrink, non-metallic patching mortar after cleaning and dampening.
- G. Final determination as to acceptability of concrete finishes and repair of surface defects will be made by Engineer.

3.10 FINISHES:

A. General: Dusting with dry cement or other mixtures or water addition during finishing is not permitted.

B. Formed Surfaces:

1. Provide rough form finish on concrete surfaces not exposed to view
2. Provide smooth form finish on interior surfaces of tank or containment walls.
3. Provide smooth form rubbed finish on concrete surfaces exposed to view.

C. Unformed Surfaces:

1. Provide float finish to surfaces scheduled to receive waterproofing, roofing, insulation, or sand-bed terrazzo.
2. Provide scratched finish to surfaces scheduled to receive concrete fills and toppings.
3. Provide steel-trowel finish to all top, horizontal and inclined surfaces not otherwise specified or indicated. This includes concrete fills and toppings and floors. Provide hand steel-trowel finish to all surfaces such as weirs or walls over which liquids will flow.
4. Provide broom finish to exterior walkways, exterior stairs, entrance platforms and loading docks.

D. Descriptions:

1. Rough Form Finish: Patch tie holes and defects. Chip or rub off fins exceeding 1/2 in. in height. Leave surfaces with the texture imparted by the forms.
2. Smooth Form Finish: Patch tie holes and defects. Remove fins flush with parent concrete and make necessary repairs. Wet and rub finned and repaired areas as described for smooth form rubbed finish, below.
3. Smooth Form Rubbed Finish: Patch tie holes and defects. Remove fins flush with parent concrete. Wet surface and rub with carborundum stone or other abrasive until uniform color and texture are produced. Complete rubbing not later than 24 hours after the curing period. Use no cement grout other than cement paste drawn from the concrete itself by the rubbing process
4. Float Finish: Prepare surfaces by tamping to force coarse aggregate away from surface, screeding with straight edges to bring surfaces to required line. Begin

floating with a hand float, a bladed power float equipped with float shoes, or a powered disk float when the bleed water sheen has disappeared and the surface has stiffened sufficiently to permit the operation.

5. Scratched Finish: Provide float finish then roughen the surface with stiff brushes or rakes before the final set.
6. Steel-Trowel Finish: Remove excess laitance from surfaces by tamping, screeding and magnesium or bull floating. Compact surface with motor-driven floats when slab has hardened so that water and fine material will not work to top and trowel smooth. Hand-trowel the surface smooth and free of trowel marks. Continue hand troweling until a ringing sound is produced as the floor is troweled. Leave surfaces with smooth hard finish free of blemishes.
7. Broom Finish: Steel-trowel surface then broom normal to direction of travel with to produce non-slip surface of uniform appearance.

3.11 METALWORK IN CONCRETE:

- A. Secure castings, inserts, conduits and other metalwork encased in concrete to prevent metalwork from being displaced or deformed during concrete work.
- B. Set anchor bolts by means of templates.
- C. Build dovetail anchor slots into new concrete against which facing brick, concrete masonry units, tile, stone or any type ashlar is to be installed. Provide vertically at 16-in. [400 mm] centers where facing brick, etc., passes by concrete. Provide one continuous anchor slot where facing brick, etc., abuts the concrete work.
- D. Aluminum embedded in concrete shall be coated to prevent galvanic corrosion with a zinc chromate primer and one of the following products:
 1. Bitumastic Super Service Black by Koppers Co., Inc.
 2. Tarmastic 100 by Porter Coatings Division, Porter Paint Co.
 3. 450 Heavy Tnemecol by Tnemec Company.
 4. Or equal.

3.12 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700 – CONTRACT CLOSEOUT.

END OF SECTION

SECTION 03732

EXISTING CONCRETE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide existing concrete preparation indicated on the drawings, specified, and as necessary to construct new concrete work or to perform concrete repair work.

1.02 RELATED WORK:

- A. Section 02050: Demolition and Alterations
- B. Section 03200: Concrete Reinforcement
- C. Section 03300: Cast-In-Place Concrete

1.03 REFERENCES - Not Applicable

1.04 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified.
- B. Concrete preparation shall not exceed the limits indicated without the written approval of the Engineer.
- C. Surfaces to be repaired shall be cleaned and roughened for proper bonding of material in conformance with the printed recommendations of the repair material manufacturer and as specified.
- D. The Engineer shall approve the surface preparation prior to installation of new concrete or repair material.

PART 2 - PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.01 PROTECTION:

- A. The Contractor shall take all necessary precautions to ensure against damage to existing work to remain in place or to be reused. Any such damage shall be

repaired or replaced to the complete satisfaction of the Engineer at no additional cost to the Owner.

- B. The Contractor shall carefully coordinate the work of this section with all other work. Construct and maintain shoring, bracing, and supports for the safety of personnel until the completion of the work.
- C. Equipment to remain in place or to be reused shall be completely covered and sealed to prevent dust infiltration.

3.02 DUST CONTROL:

- A. Dust resulting from concrete preparation shall be controlled to prevent spread of dust to equipment or occupied areas and to avoid creation of a nuisance in the surrounding areas.
- B. Use of water is not permitted when it may result in or create hazardous or objectionable conditions such as flooding or ice formation.

3.03 CORE DRILLING:

- A. All holes larger than one inch diameter shall be core drilled.
- B. Size and locate holes to be cored where indicated.
- C. Coring to be performed with a non-impact rotary tool and diamond core drills of the proper size.
- D. Equipment shall comply with all OSHA Standards.
- E. A lubricant coolant shall be used to maintain dust free operation.
- F. Concrete remaining after coring and removal shall be roughened by chipping or wet sandblasting to expose coarse aggregate and enhance bond of new materials to existing concrete.
- G. Remove all plugs and inserts used to support or secure the coring equipment.
- H. Repair fractures that may occur in the existing concrete as a result of the coring operation with pressure injected epoxy adhesive at no additional expense to the Owner.

3.04 SAWCUTTING:

- A. Sawcut control joints in concrete to the depth and locations indicated.
- B. Sawcut expansion joints in concrete to the width, depth, and locations indicated.
- C. Sawcut new openings in concrete including all reinforcement except where otherwise indicated on the drawings. The sawcut shall not extend beyond the limits of the new openings. No over-cuts permitted.
- D. The Contractor's equipment shall comply with all OSHA Standards. A gas operated saw may be used only for outside work unless noise control and mechanical ventilation is provided. A lubricant coolant shall be used to maintain a dust free operation.
- E. When sawing reinforced concrete, the cutting shall be done so as not to damage the bond between concrete and reinforcing steel to be left in the existing structure.
- F. Concrete panels to be sawed shall be adequately shored or braced prior to the start of sawing operation. The panels shall be constantly checked for partial cracking during the sawing operation and may require additional shoring or bracing to prevent a partial release during the sawing operation.
- G. The concrete which is to remain shall be roughened by chipping or wet sandblasting to expose coarse aggregate to enhance bond of new materials to existing concrete.
- H. Repair fractures that may occur in the existing concrete as a result of the sawcutting operation with pressure injected epoxy adhesive at no additional expense to the Owner.

3.05 CHIPPING:

- A. Chip away cracked, loose, and deteriorated concrete from sound concrete to remain using a hammer and chisel. Pneumatic or electric hammers of 10-lb. weight or less are permitted if they can be used without damaging the sound concrete to remain and without damaging the bond between concrete and reinforcing steel to be left in the existing structure. Heavy duty pneumatic hammers are not permitted except in areas of complete concrete demolition and removal, provided they can be used without shattering, disturbing or cracking the concrete which is to remain, and without damaging the bond between concrete and reinforcing steel left in the existing structure.
- B. Chipping shall be done in a manner that eliminates all abrupt offsets of the surface and sudden changes in thickness of the new or repair work.

1. Edges to receive concrete or cementitious mortar repair shall have one-inch deep minimum square shoulder at the perimeter of the cavity.
 2. Edges to receive shotcrete or epoxy mortar repair shall have tapered edges at the perimeter of the cavity.
- C. Reinforcement that is to remain in the completed structure shall be cleaned of all concrete, mortar, and rust.
- 3.06 CLEANING STEEL REINFORCEMENT:
- A. Do not use chisels on the reinforcing steel itself when chiseling concrete from reinforcement or otherwise disturb the bond of the steel to the undamaged concrete.
 - B. Do not use reinforcement as a brace for prying.
 - C. Clean rust and other deleterious material from exposed reinforcement that is to remain.
- 3.07 CLEANING EXPANSION JOINTS:
- A. Remove all sealant, backer rod, dirt, and debris from expansion joints indicated. Repair damage to existing concrete that results from joint cleaning, to the satisfaction of the Engineer and at no additional cost to the Owner.
- 3.08 SANDBLASTING:
- A. Existing concrete that is to receive new or repair materials, and will be located under new split waterstops shall be cleaned and roughened to expose coarse aggregate by chipping or wet sandblasting followed by washing with an air-water jet to enhance bond of the new materials to the existing concrete.
 - B. Surface gouging shall be avoided.
 - C. Protect all surfaces not scheduled for repair.

3.09 WATERBLASTING:

- A. Cracked concrete to be repaired with pressure injected epoxy adhesive shall be waterblasted to remove all dirt and deleterious material within the cracks, which would reduce bond of the epoxy to the existing concrete to the complete satisfaction of the Engineer, the epoxy supplier and applicator.
- B. Protect all surfaces not scheduled for repair.

3.10 DEBRIS AND CLEANING:

- A. Slurry, tailings and debris generated from the preparation work shall be removed from the site.

3.11 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION
VERTICAL TURBINE PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Install owner furnished turbine pumps, motors, and appurtenances as indicated and in compliance with Contract Documents.
- B. Provide for field testing and closeout as specified below.

1.02 REFERENCES:

- A. American Society for Testing and Materials International (ASTM):
 - 1. A36: Standard Specification for Carbon Structural Steel.
 - 2. A48: Standard Specification for Gray Iron Castings.
 - 3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 4. A120: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses.
 - 5. A283: Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - 6. A322: Standard Specification for Steel Bars, Alloy, Standard Grades.
 - 7. A395: Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
 - 8. A536: Standard Specification for Ductile Iron Castings.
 - 9. A582: Standard Specification for Free-Machining Stainless Steel Bars
 - 10. A743: Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application.
 - 11. B148: Standard Specification for Aluminum-Bronze Sand Castings
 - 12. D2240: Standard Test Method for Rubber Property – Durometer Hardness.
- B. American National Standards Institute (ANSI):

1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

C. American Society of Mechanical Engineers (ASME):

1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.

D. American Bearing Manufacturers Association (ABMA):

1. 9: Load Ratings and Fatigue Life for Ball Bearings.
2. 11: Load Ratings and Fatigue Life for Roller.

E. Hydraulic Institute (HI):

1. Current Standards.
2. 9.8: Pump Intake Design
3. 14.6: Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

F. NSF International (NSF):

1. 61: Drinking Water System Components - Health Effects

G. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

1.03 SUBMITTALS:

~~A. Submit the following with the Bid:~~

- ~~1. Each pump life cycle costs given information in Attachment I. Life cycle costs to be for a 20 year period.~~

~~B. Submit the following shop drawings in accordance with Section :~~

- ~~1. Data regarding pump and motor characteristics and performance:~~
 - ~~a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency and NPSHr.~~

~~(1) For units of same size and type, provide curves for a single unit only.~~
 - ~~b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller~~

- ~~diameters available, acceptable operating range (AOR) and preferred operating range (POR).~~
- ~~e. Results of shop performance tests as specified.~~
 - ~~d. Submit curves for guaranteed performance, and shop performance tests on 8 1/2 inch by 11 inch sheets, one curve per sheet.~~
 - ~~e. Listing and value of all internal friction losses for the entire pump assembly.~~
 - ~~f. Shaft power loss~~
 - ~~g. Thrust bearing power loss~~
- ~~2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide NPSHr curve for each speed.~~
 - ~~3. Shop drawing data for accessory items.~~
 - ~~4. Certified setting plans, with tolerances, for anchor bolts.~~
 - ~~5. Manufacturer's literature as needed to supplement certified data.~~
 - ~~6. Operating and maintenance instructions and parts lists.~~
 - ~~7. Listing of reference installations as specified with contact names and telephone numbers.~~
 - ~~8. Certified results of hydrostatic testing.~~
 - ~~9. Certified results of dynamic balancing.~~
 - ~~10. Bearing temperature operating range for the service conditions specified.~~
 - ~~11. List of recommended spare parts other than those specified.~~
 - ~~12. Shop and field inspection reports.~~
 - ~~13. Bearing Life: Certified by the pump manufacturer. Include design data.~~
 - ~~14. Pump shop test results.~~
 - ~~15. Motor shop test results.~~
 - ~~16. Qualifications of field service engineer.~~
 - ~~17. Recommendations for short and long term storage.~~

18. ~~Resonant frequency analysis.~~
 19. ~~Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.~~
 20. ~~Special tools.~~
 21. ~~Number of service person days provided and per diem field service rate.~~
 22. ~~Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.~~
 23. ~~Recommended location of discharge pressure gauges.~~
 24. ~~Manufacturer's product data, specifications and color charts for shop painting.~~
 25. ~~The latest ISO 9001 series certification.~~
 26. ~~Provide a sealed drawing for each pump service showing the pumps and motors, including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.~~
 27. ~~Material Certification:~~
 - a. ~~Provide certification from the equipment manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.~~
 - b. ~~Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.~~
- C. ~~A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.~~
1. ~~If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.~~

2. ~~Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.~~

~~1.04 SPARE PARTS:~~

- A. ~~Comply with the requirements specified in Section .~~
- B. ~~Provide spare parts that are identical to and interchangeable with similar parts installed.~~
 1. ~~For each pump:~~
 - a. ~~One complete set of gaskets.~~
 - b. ~~One mechanical seal repair kit for each pump provided with mechanical seals.~~
 - c. ~~One set of wearing rings.~~
 2. ~~For each set of pumps of the same size and performance.~~
 - a. ~~One set of all special tools required.~~

~~1.05 QUALITY ASSURANCE:~~

- A. ~~Comply with the requirements specified in Section .~~
- B. ~~Pumps shall be the product of one manufacturer.~~
- C. ~~Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.~~
- D. ~~Welding: In accordance with latest American Welding Society Code or equivalent.~~
- E. ~~Shop tests as specified.~~
- F. ~~Provide pumps, motors, discharge columns, discharge heads and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.~~
 1. ~~The pumping system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.~~
 - a. ~~The Pump Manufacturer shall coordinate the variable frequency motor controllers with the motor manufacturer and submit as part of the shop drawings a written statement signed by the pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the~~

~~variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.~~

- G. ~~Services of Manufacturer's Representative as stated in Section and as specified herein.~~
- H. ~~Provide services of factory trained Service Technician, specifically trained on type of equipment specified:~~
- ~~1. Service Technician must have a minimum of five (5) years of experience, all within the last seven (7) years, on the type and size of equipment.~~
 - ~~2. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.~~
 - ~~3. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:~~
 - ~~a. 1 person-day.~~
 - ~~4. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.~~
 - ~~a. 1 person-day.~~
 - ~~5. Field Performance Testing: Field performance test equipment specified.~~
 - ~~a. 1 person-day.~~
 - ~~6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.~~
 - ~~a. 1/2 person-day.~~
 - ~~7. Credit to the Owner, all unused service person days specified above, at the manufacturer's published field service rate.~~
 - ~~8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.~~

- I. ~~Manufacturer of pumps shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.~~
- J. ~~For variable speed pump systems the pump manufacturer must perform an analysis of the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure.~~
 - 1. ~~Submit a copy of these calculations for the record.~~
 - 2. ~~Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point within the speed range required.~~
 - 3. ~~Provide and install such additional devices at no additional cost to the Owner.~~

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section .

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

- A. Pump capacities and operating data are indicated in the Process Pump Schedule below.

PROCESS PUMP SCHEDULE															
TAG NO.	NUMBER OF UNITS	NAME	LOCATION	TYPE	RATING POINT				MIN. SUCTION BOWL/COLUMN AND DISCHARGE HEAD SIZE (IN.)	PUMP RPM MAX.	SEAL TYPE	MOTOR DATA			DRIVE TYPE
					CAPACITY (GPM)	HEAD (FEET)	MIN. WATER TO WIRE EFF. %	SHUTOFF HEAD FT.				HP	RPM (MAX.)	ENCL. TYPE	
RWP-3 & 4	2	RAW WATER PUMP	RAW WATER PUMP STATION	VERTICAL TURBINE	5,000	231	76	387	22.5/14	1,770	MECH.	400	1,800	ODP	DIRECT

PROCESS PUMP SCHEDULE NOTES:

1. VARIABLE FREQUENCY DRIVE.
2. MINIMUM SPEED OPERATION 3,500 GPM AT 182 FEET.
3. PUMP DESIGN HEAD AT DISCHARGE FLANGE. MANUFACTURER TO ADD ALL INTERNAL LOSSES.
4. MAXIMUM NUMBERS OF STAGES: 2

- B. Raw Water Pumps: Pump raw water from a reservoir. Before entering the pumping station water will not pass through intake screens.
- C. ~~Equipment Limitations:~~
 - a. ~~Maximum Total Pump Dry Weight excluding motor: 3000 lbs.~~
 - b. ~~Maximum column section length: 120 in.~~

e. ~~Maximum Motor Weight: 1,600 lbs.~~

D. ~~Design Heads:~~

1. ~~The head requirements indicated are the heads required at the pump's discharge head flange.~~
2. ~~For wet pit pumps, the pump manufacturer must include all internal losses from the intake bell to the discharge head flange.~~

2.02 ~~MANUFACTURERS:~~

A. ~~Vertical Turbine Pumps:~~

1. ~~Afton~~
2. ~~Flowserve~~
3. ~~Peerless Or acceptable equivalent~~

~~PUMP CONSTRUCTION:~~

- A. ~~Pumps: Vertical turbine pumps, driven as indicated in the Process Pump Schedule.~~
- B. ~~Pump configuration as indicated in the Process Pump Schedule.~~
- C. ~~Rotation: Counterclockwise, viewed from the drive end.~~
- D. ~~Design and proportion all parts of pump for the service specified and indicated.~~
- E. ~~Pumping assemblies, including pump, and motor, to operate within vibration and bearing temperature limits specified over the full operable range of the pump performance.~~
- F. ~~Provide no more than the number of stages as indicated in the Process Pump Schedule to meet the performance specified and indicated.~~
- G. ~~Provide room for inspection, repair and adjustment.~~
- H. ~~Equip pumping assemblies with all specified and required accessories including lifting attachments.~~
- I. ~~Apply a never seize compound to all bolts.~~
- J. ~~Bowl Assembly:~~
 1. ~~Pump Bowls: Free from blow holes, sand holes and all other defects and faults. Bowls to be coated with a NSF 61 coating as specified herein.~~
 - a. ~~Cast Iron ASTM A48 Class 30.~~
 - b. ~~Provide flanged bowls with Type 316 stainless steel hardware.~~

2. ~~Pump Shaft:~~
 - a. ~~ASTM A582, Type 416 Stainless Steel.~~
3. ~~Impellers:~~
 - a. ~~Type: Turbine.~~
 - b. ~~Material:~~
 - (1) ~~Aluminum Bronze ASTM B148, no lead content.~~
 - (2) ~~Stainless steel ASTM A743 CF8M.~~
 - c. ~~Provide bowl and impeller wear rings:~~
 - (1) ~~Aluminum Bronze ASTM B148 bowl and impeller wear rings, no lead content.~~
 - (2) ~~Stainless steel ASTM A743 CA-40 bowl and impeller wear rings.~~
 - d. ~~Provide the impellers secured to the shaft with a tapered lock bushing for shafting 2 3/16 inches and smaller and thrust washer, key and snap ring for shafting larger than 2 3/16 inches.~~
 - e. ~~Dynamically balance impellers.~~
4. ~~Suction Bell with flared inlet:~~
 - a. ~~ASTM A48 Class 30 cast iron with ceramic epoxy lining~~
 - b. ~~Suction Bell Lining:~~
 - (1) ~~Manufacturer:~~
 - (a) ~~Belzona Supermetalgilde~~
 - (b) ~~Deveon Brushable Ceramic Blue~~
 - (2) ~~Type: Ceramic filled epoxy.~~
 - (3) ~~Percent Solids by Volume: 100 percent.~~
 - (4) ~~Provide two coats 8 to 15 mils thick with total minimum DFT of 20 mils.~~
 - (5) ~~Cured Hardness: 90D in accordance with ASTM D2240.~~

~~(6) Surface preparation, mixing and application and safety requirements shall be in accordance with the lining manufacturer's printed instructions and as specified.~~

~~(7) NSF 61.~~

~~5. Suction Bell Bearing:~~

- ~~a. Copper Bismuth Alloy, Federalloy® or equal.~~
- ~~b. Provide a sand collar of Copper Bismuth Alloy, Federalloy® or equal, attached to shaft with a Type 316 stainless steel set screw arrangement.~~
- ~~c. Provide a suction bowl plug or cap of cast iron.~~

~~6. Intermediate Bowl Bearings:~~

- ~~a. Copper Bismuth Alloy, Federalloy® or equal.~~

~~7. Discharge Bowl and Connector Bearings:~~

- ~~a. Provide bearings of bronze Copper Bismuth Alloy, Federalloy® or equal.~~

~~8. Discharge Bowl:~~

- ~~a. Provide a flanged discharge bowl of ASTM A48 Class 30 cast iron.~~

~~K. Discharge Head:~~

~~1. Type:~~

- ~~a. Above ground~~
- ~~b. Provide a discharge elbow:~~
 - ~~(1) Minimum three (3) piece mitered 90 degree bend.~~
- ~~c. Size: 14 inch~~

~~2. Material:~~

- ~~a. ASTM A120, A53 and A283 Grade D steel.~~
 - ~~(1) Provide a minimum of four (4) supports at maximum of 90 degree spacing from baseplate to motor flange for variable speed application.~~

~~3. Provide integral flange for bolting to column flange.~~

4. ~~Provide a foundation plate of cast iron ASTM A48 Class 30 or fabricated steel ASTM A36.~~
5. ~~Connection:~~
 - a. ~~Flanged: ASME B16.1, 150 lb.~~
6. ~~Provide pump head and baseplate designed to withstand all thrust conditions imposed by the pump and driver during operation at the specified and indicated conditions and at future conditions specified and indicated.~~
7. ~~Provide pumps with vertical solid shaft (VSS) motors with spacer type couplings.~~
8. ~~Provide neoprene gasket between top column flange and discharge head.~~
9. ~~Provide a plugged pre-lubrication connection with a Type 316 stainless steel plug.~~
10. ~~Provide a minimum 3/4 inch NPT drain connection.~~
11. ~~Provide Type 316 stainless steel guard and hardware.~~

~~L. Column and Shafting:~~

1. ~~Type: Flanged with Open Line shaft and Type 316 stainless steel bolts and nuts.~~
 - a. ~~Size: 14 inch~~
2. ~~Material: Steel ASTM A53 Grade B.~~
 - a. ~~Provide section lengths as indicated, but no longer than 10 feet 0 inches.~~
3. ~~Provide pipe thickness in accordance with AWWA standard wall pipe.~~
4. ~~Line shaft and couplings: AISI Type 416 stainless steel.~~
5. ~~Bearing retainer: Copper Bismuth Alloy, Federalloy® or equal.~~
6. ~~Bearing: Copper Bismuth Alloy, Federalloy® or equal.~~
7. ~~Line shaft sleeve at bearings: Type 316 stainless steel.~~
8. ~~Connector Bearing: Bronze Copper Bismuth Alloy, Federalloy® or equal.~~
9. ~~Hardware: Type 316 stainless steel.~~
10. ~~Transition: Provide a tapered transition where size of discharge bowl and column are not the same.~~

11. ~~Provide lifting lugs with lifting eyes 180 degrees apart below each column flanged connection for pump removal.~~

2.04 ~~MECHANICAL SEALS:~~

- A. ~~Provide stuffing box with mechanical seal, Chesterton Type 180 or equal.~~
- B. ~~Provide a 1/2-inch NPT water flush connection~~

2.05 ~~MOTORS:~~

- A. ~~Provide in accordance with Section and as specified and indicated.~~
- B. ~~Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.~~
- C. ~~Motor enclosure and motor speed: As indicated in the Process Pump Schedule.~~
- D. ~~Provide motors with base supports with machined registered joints for mounting on pump discharge head.~~
- E. ~~Provide vertical solid shaft (VSS) motors and non-reverse ratchets.~~
- F. ~~In addition to the requirements for bearings specified under Electric Motors in Section, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.~~
- G. ~~Overall sound pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave band frequency analyzer conforming to ANSI S1.11. Determine overall sound pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.~~
- H. ~~Operate without overheating at the speeds specified and indicated.~~
- I. ~~Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.~~
- J. ~~Premium efficiency with nominal and minimum efficiencies per NEMA MG1.~~
- K. ~~Rating: 460V, 3 PH, 60 Hertz.~~
- L. ~~Insulation: Class F with Class B temperature rise, 40 degrees C ambient.~~
- M. ~~Site Altitude: Less than 3,300 feet above sea level.~~
- N. ~~Temperature Monitoring System:~~

1. ~~The resistance Temperature Detector (RTD) monitor system, for motor bearings:~~
 - a. ~~Platinum, 100 ohm RTDs embedded in the motor windings for each phase and in each bearing of the motor.~~
 - b. ~~Continuously monitor the temperature of the three wire bearing RTDs.~~
 - c. ~~Include a display and switch to permit monitoring of actual bearing temperature.~~
 - d. ~~Provide an adjustable alarm feature to select an alarm temperature. Selection of temperature range by pump manufacturer. Alarm when bearings reach the selected temperature.~~
 - e. ~~Provide an alarm light until reset, and a set of contacts, rated not less than 5 amps at 120 VAC.~~
 - f. ~~Temperature range as recommended by the motor manufacturer.~~
 - g. ~~Trip point repeatability of not more than 1.8 degrees F. detection circuit response time of 5 milliseconds, maximum; deadband, 2 percent maximum; calibration accuracy of 1 degree F. Mount monitors in variable frequency motor controllers as indicated and specified in Section.~~

2.06 DRAIN AND VENT PIPING:

- A. Furnish and install drain and vent piping in accordance with the Drawings and Technical Specifications.

2.07 GAUGES:

- A. Furnish and install gauges in accordance with the Drawings and Technical Specifications.

2.08 ~~SHOP PAINTING:~~

- A. ~~Primer and Finish Paint: Shop apply to all exterior ferrous surfaces and interior of column and discharge head, NSF 61 high solids epoxy.~~
- B. ~~Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.~~
- C. ~~Provide additional shop paint coating for touch up to all surfaces after installation and testing is completed and equipment accepted.~~

2.09 ~~SHOP TESTING:~~

- A. ~~Provide motor shop testing in accordance with Section~~

~~B.~~ Pump Tests:

- ~~1. Test pump bowls, column and discharge head under a hydrostatic head of at least 75 psi or 150 percent of rated shutoff head, whichever is greater. Test pump assembled.~~
- ~~2. Provide certified performance tests as specified herein for all pumps.~~
- ~~3. Certified performance testing.~~
 - ~~a. Run pump at full speed rating point for 60 minutes prior to start of any testing.~~
 - ~~b. Full speed tests:~~
 - ~~(1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run-out. Test points must be at the conditions specified and indicated.~~
 - ~~(2) Take readings to determine flow, differential pressure, rpm, horsepower, and efficiency.~~
 - ~~(3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified NPSH available. Test with the job submergence as indicated.~~
 - ~~c. Variable speed tests:~~
 - ~~(1) Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.~~
 - ~~(2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one point of test at the minimum rating point.~~
 - ~~(3) Run a second test at a speed approximately midway between full and minimum speed.~~
 - ~~(4) Run addition tests for each reduced speed operating condition specified and indicated.~~
 - ~~d. Factory tests on pumps:~~
 - ~~(1) String test complete assembly with job motor, discharge head, bowl assembly and column.~~

- ~~(a) Use one (1) job motor that is shipped to the pump testing facility for use in these pump tests.~~
 - ~~(b) Use factory variable frequency motor controller~~
 - ~~(c) Test pumps assembled with a nominal minimum 10 feet of column or as many sections as is practical for the manufacturer's test pit.~~
 - ~~(d) Provide performance curves adjusted for any column length that is not included in the factory string testing.~~
- ~~e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.~~
- 4. ~~Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.~~
- 5. ~~Testing Acceptance Grade and Tolerances:~~
 - ~~a. ANSI/HI 14.6 Acceptance Grade: 1U.~~
 - ~~b. Efficiency Tolerance: 0 percent.~~
 - ~~c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.~~
- 6. ~~In the event that specified tests indicate that pump or motor will not meet specifications, Engineer has the right to require additional complete witnessed tests for all pumps and motors at no additional cost to the Owner.~~
- 7. ~~Repeat tests until specified results are obtained.~~
- 8. ~~Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.~~

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.
- B. Provide threaded caps for protection of nuts and bolt threads on the bolts and nuts of the column pipe flanges and bowl flanges.

- C. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment.

3.02 FIELD TESTING:

- A. Contractor to provide for and coordinate all field testing with Factory Representative as specified below.

1. Bump motor to ensure that motor has been connected for proper rotation.
2. Perform field tests on each installed pump to demonstrate that it performs according to the factory test data. If the measured flows are more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.
3. Conduct vibration level tests with pumps operating at their rated capacity. Adjust or replace pumps that exceed the maximum vibration levels.
4. Test the pump system to determine its overall efficiency. This test shall consist of measuring flow, discharge pressure, pumping levels, and electrical input kilowatts to the motor at a minimum of five points evenly spaced on the pump curve and determining the ratio of power input to the water to the electrical input power to the motor ("wire-to-water efficiency"). Submit results of this test to the Engineer.

3.03 FIELD TOUCH-UP PAINTING

- A. Provide for touch-up painting

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section .

END OF SECTION

SECTION 13120

CUSTOM PRE-ENGINEERED BUILDING

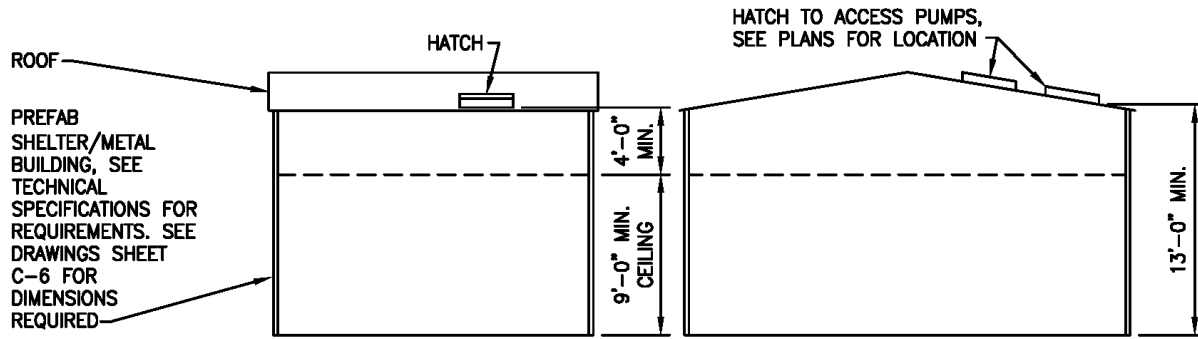
Work shall be accomplished in accord with all applicable state and local building codes and also in accord with specifications listed or shown on the Design Professional's project design drawings.

Summary of Work

1. Prepare signed/sealed building (shelter) plans after award of contract and after receiving notice to proceed from Owner. Sign/seal must be by a Registered Florida Professional Engineer. Submit Certificate of Design in accordance with 01300 Submittals.
2. Submit a complete City of Marco Island building permit application package, and obtain a building permit after award of contract and after receiving notice to proceed from Owner. Contractor will be reimbursed for City of Marco Island permit fees in accordance with the Contract Documents.
3. Submit and obtain approval of shop drawings from Owner's Engineer after award of contract and after receiving notice to proceed from Owner.
4. Furnish all materials for and install/construct a 450 s.f. shelter at the city of Marco Island's Marco Lakes facility. The shelter may be constructed of metal, concrete block, metal frame with durable fabric sheathing, or composite materials. The shelter may be pre-manufactured off-site and erected on-site or fully constructed on-site. The shelter may be constructed over the proposed slab shown on the drawings. The shelter is to have a foundation system independent of the floor slab. This shelter contract will not include any water, sewer, or electrical. However, ventilation for the intended use must be considered in design. The shelter is not intended for extended human occupancy. Lightning protection and grounding is required.
5. Obtain building permit inspection approvals and a certificate of occupancy from the City of Marco Island building department.
6. Verify all dimensions prior to design and construction of shelter.

Construction Standards

1. All construction shall meet the requirements of the latest version of the Florida Building Code. Shelter shall be designed to withstand 140 mph windstorm.
2. The shelter shall be designed to have a minimum lifespan of 20 years.
3. The shelter shall have a minimum of 450 s.f. of area from floor level to rising above the floor level as shown in the diagram below. The basis for height design is Peerless Vertical – 16HH pumps (400 hp each). Final dimensions to accommodate actual pump purchased.



ACCEPTABLE END PROFILE ELEVATIONS

NOT TO SCALE

4. Shelter floor plan shall be rectangular or square. Round or oval floor plan is not acceptable.
5. The shelter shall have openings as required to allow air flow (ventilation) through the shelter while the pumps are running.
6. The shelter shall have two roof hatch openings. Size and location to accommodate each pump.
7. Exposed exterior metal surfaces shall be primed with epoxy primer and painted with polyurethane enamel paint. Surfaces to be painted shall be free of rust, corrosion, dirt, grease, debris, oil, etc... Factory painted exposed metal is also acceptable (finish painted, not just primed). Color to be selected by Owner's project manager.
8. Exposed concrete surfaces shall be primed and painted.
9. Structural metal tubing (round, square, oval, or rectangular cross section), if used, shall be Allied Gatorshield galvanized or Owner approved equal.
10. Structural metal framing members (other than tubing) shall be galvanized.
11. Corrugated sheet metal cladding if used shall be minimum 24 gauge thickness.
12. The shelter shall be weather-tight.
13. If needed Contractor shall excavate for and construct foundation piers, footings, etc. No soil borings tests or reports will be provided by Owner. The Contractor may conduct soil boring tests at Contractor's expense if needed or desired.
14. Cladding fabric, if utilized, shall be ECP Nova Shield II with ArmorKote or Owner approved equal. Color to be selected by Owner's project manager.
15. Supplier shall attend a pre-construction meeting with Owner's representatives.

END OF SECTION

SECTION 13300

UTILITY CONTROL INSTRUMENTATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test the instrumentation and control system, furnished by a single System Supplier. Provide equipment, installation, services, and appurtenances required to achieve a complete, integrated, and fully operational system.
- B. The System Supplier, system integrator shall be required to demonstrate recent past experience in the engineering, design, manufacture, and commissioning of instrumentation and control equipment of comparable size to that being proposed.
- C. The Contractor shall submit the qualifications of the proposed system supplier/integrator within 30 days of the notice to proceed. The Contractor shall receive approval of the supplier/integrator prior to submitting shop drawings. Delay by the Contractor in submitting the supplier/integrator or by submitting a supplier/integrator that is not qualified shall not be grounds for an extension of time.
- D. Furnish full technical details of all instrumentation offered.
- E. The Supplier of this specification shall be responsible for the coordination of all other equipment furnished in this contract with overall control system requirements.

1.02 RELATED WORK:

- A. Section 1300 – Submittals
- B. Section 1400 – Quality Assurance
- C. Section 1610 – Delivery, Storage and Handling
- D. Equipment Division 15.
- E. Refer to applicable sections of Division 16 - Electrical for conduit and wiring between panels and field-mounted devices to be furnished and installed.

1.03 REFERENCES:

- F. Federal Specifications: WW-T-799F; Tube, Copper, Seamless, Water, (For Use with Solder-Flared-Or Compression Type Fittings).

- G. National Fire Protection Association: NFPA 70.
- H. American Petroleum Institute (API) RP-550 Manual of Installation of Refinery Instruments and Control Systems.
- I. The Instrument, Systems and Automation Society (ISA) S5.2, S5.3 and S5.4, Instrument Loop Diagrams, standard.
- J. National Electrical Manufacturers Association (NEMA) Publication, General Standards for Industrial and Control Systems, ICS1 and Industrial Controls and Systems ICS2.

1.04 SYSTEM DESCRIPTION:

- K. Equipment, cabinets and other devices furnished hereunder shall be suitable for continuous use in the intended application. The system shall consist of current production products of a single manufacturer wherever possible. Equipment shall be of a design that allows field maintenance and modification.
- L. Terminations:
 - 1. Provide terminations for future connection to existing plant network.
 - 2. Provide 4-20mA DC signal wiring separated from digital inputs and outputs and power.
 - 3. Provide continuous conductor from field for all signal wiring.
 - 4. Provide terminal strips numbered with the signal termination numbers as indicated on the shop drawings. Provide wire numbers on wires at terminal blocks and all connections.
 - 5. Terminal numbers shall be sequential on the terminal blocks. Provide 25 percent spare terminal blocks for each type of signal.
- M. Run grounding wires with special care to provide the least possible resistance.
- N. Provide electronic equipment of the manufacturer's latest design and coated to prevent its' contamination by dust, moisture, or fungus. Provide field mounted equipment and system components suitable for dusty, humid, and corrosive conditions specific to the installation location.
- O. Design all instrumentation equipment to operate on 120Vac, +/-10%, at 60Hz, except as specifically noted. Provide power supplies, regulators, and constant-voltage transformers to allow compliance with the above.

- P. Provide electronic type solid-state instrumentation utilizing linear transmission signals of 4-20mADC, (milliampere direct current), except as specifically noted. Instruments within the same panel or enclosure may be operated by 1-5 Vdc, (volts direct current), provided it is derived from a 4-20mADC signal.
- Q. Provide 4-20mADC outputs capable of driving a 750 ohm load from all transmitters, controllers, and signal processing devices. Inputs to controllers, recorders, indicators, signal processing devices shall be 4-20mADC, or 1 to 5 Vdc derived from a precision 250 ohm resistor in series with the signal loop.
- R. Convert non standard signals into compatible standard signals at their source. Zero based signals are not acceptable.
- S. Number wiring in accordance with the numbering system used on the instrument submittal drawings.
- T. Group wiring within the panel according to function, and harness together, or place within ducts and secured to the panel structure.
- U. Provide each instrument with mounting hardware, floor-stand, wall bracket, or instrument rack as shown on the drawings, manufacturers' installation instructions, and as approved in the submittals or as required.
- V. Provide each transmitter with a digital integral or conduit-mounted indicator, calibrated 0-100% of signal output and engineering units. Indicator to have an accuracy of 2% of full scale.
- W. Provide transmitters, pressure switches or pressure indicators with manifold so instrument may be isolated from process for calibration and setting zero. Mount the manifold to the process and the transmitter to the manifold. Block and bleed shall use a single handle action to insure correct valve sequence. Provide ½-inch rigid SS tubing for process connections to manifold. All manifolds shall be manufactured by AGCO or equal.
- X. Design the system and equipment used therein, to resume normal operation without manual intervention, following resumption of power after a power failure.
- Y. Provide UL approved materials and equipment.

1.05 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Submittals shall be bound in Cardinal, Wilson Jones, National, or equal, 8-1/2 x 11 inch three-D-ring binders with hardback; two inch maximum

ring size. If multiple binders are used, correlate data into related consistent groupings. All drawings shall be provided with reinforced punched binder tabs.

2. Instrument Submittals:

- a. Sales bulletins and other general publications are not acceptable as submittals except where necessary to provide supplemental technical data.
- b. Submit six sets each of:
 - (1) Component manufacturing data sheets indicating pertinent data and identifying each component by tag number and nomenclature as indicated on drawings and in specifications,
 - (2) System piping schematic and wiring schematic each on single drawing with full description of operation (component identification on schematic as indicated in a. above),
 - (3) Component drawing showing dimensions, mounting, and external connection details.
 - (4) Provide instrument loop diagrams in accordance with ISA-5.4. Identify range of all analog devices. Identify all termination cabinet and panel terminal numbers. Show all loops in their entirety including control wiring within the reduced voltage starters and between all field devices including those devices furnished under other Divisions. Clearly identify which selector switch contacts are closed in each selector switch position. Identify normally open or normally closed status for all relay and switch contacts. Assign each wire a unique wire number. Show all power sources, grounding, isolation and lightning protection. Show both analog and discrete signals on a single loop diagram. Show where the analog signal ground shield shall be cut and taped. Submit loop diagrams on 11 inch by 17 inch sheets. The loop diagrams shall be bound in a 3-ring 11 inch by 17 inch binder. The loop diagrams shall be sequential by loop number. The title shall include the loop number. Submittals which are not properly ordered will not be reviewed.
 - (5) Front panel layout and any other panel surface containing instrumentation.

- (6) List of all spare parts. All manufacturer recommended spare parts shall be supplied in addition to specified spare parts.
 - (7) Loop/equipment protective devices as required, and their proposed application.
 - c. Contain all material in not more than two submittals, one for all in-line instrumentation and one for remainder of equipment. Partial submittals not reviewed; however, in-line devices (flow tubes, etc.) where delivery is required to meet construction schedules, may be submitted separately.
 - d. Identify any specification section where exceptions are being taken or an "or equal" piece of hardware is being proposed.
 - e. Any changes or modifications to previously submitted materials shall be resubmitted prior to installation.
- 3. Operation and Maintenance Manuals:
 - a. Submit operating and maintenance instructions and separate parts lists separately from instrumentation submittal. Incorporate functional description of entire system.
 - b. Submittal shall include the following:
 - (1) Data sheet describing each element in detail, including manufacturer, part number, calibration values, and all information pertaining to the element. Include brief description of each device.
 - (2) Manufacturer specification sheets for each element. All specification sheets shall be properly annotated.
 - (3) Complete spare parts list.
 - (4) Submittal shall be in the same form as the Instrumentation Submittal.
 - (5) All information shall be in one submittal.
- 4. Submit "record copy" of all drawings previously submitted for review within 30 days after completion of system installation as part of operating and maintenance instructions. Show all changes and modifications made during installation. Define special maintenance requirements particular to system along with special calibration and test procedures.

5. Submit brief description of calibration procedures listing actual calibration and test equipment. Include typical calibration sheet and description of loop check procedures, provide typical loop check sheet.
6. Provide manufacturer's certified statement of installation approval containing authorization to energize system.
7. Provide a listing of the materials recommended for each service specified and indicated.
8. ISO 9000 certification and quality system plan.
9. Shop test plan and results specified in paragraph 2.06.

B. Material Certification:

1. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.
2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. Certificate of Unit Responsibility:

1. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required."
2. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

- D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the

specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up specification sections and the detailed justifications for any requested deviation or clarification will result in rejection of the entire submittal with no further review and consideration.

1.06 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified.
- B. The contractor shall submit the name and qualifications of their control system integrator for this section of the specification.
 1. The control system integrator shall have completed four projects over the last five years of similar size and type. Provide description of project. The project description should include: size and type of project, equipment and software used and the reason the particular hardware and software were used for the project application because that is what the Owner requested is not adequate.
 2. Provide list of staff that will be working on the project. Provide staff qualifications. The qualifications should show current factory (PLC and HMI) training on the products that will be used for this project.
- C. Substitutions on functions specified will not be allowed. .
- D. The Contractor shall have system supplier coordinate with mechanical and electrical systems suppliers to identify any signal isolation, signal boosting devices or auxiliary relays that may be required to complete the system.
- E. Provide auxiliary devices for proper operation, such as transducers, relays, current/current isolators, and signal boosters for interfacing with equipment provided under this and other sections of this specification.
- F. Provide supervisory services of competent factory-trained service personnel specifically trained on the type of equipment specified, for a minimum period of one 8-hour days, excluding travel time, during construction to assist Contractor in the location of sleeves, methods of installing conduits and special cables, mounting, piping, and wiring of one of each type of device, and methods of protecting all equipment prior to being placed into service. Upon completion of installation, provide competent service personnel for a period of not less than one 8-hour days,

excluding travel time, for field check-out of the System in the presence of the Engineer, for calibration and start-up of equipment

- G. Instrument Calibration: Calibrate electronic and pneumatic test equipment within 6 months prior to use. Accuracies of test equipment shall be traceable to Bureau of Standards.
- H. Instrumentation accuracy shall be in accordance with manufacturer's standard, unless otherwise stated herein.
- I. Calibrate all instrumentation in the presence of the Engineer. Provide calibration tag to all calibrated instruments. The calibration tag shall have the name and phone number of the supplier/integrator who performed the calibrations with the date of calibration and the date of the next calibration. The tag shall be signed by the individual that performed the calibration. Linkage or range adjustments sealed by colored lacquer immediately following calibration. Provide calibration records to the Engineer prior to substantial completion.
- J. System energizing not allowed prior to receipt of certified statement from Contractor and supplier approving system and authorizing energizing of system. Exception, system supplier's representative.
- K. Protect materials and equipment against damage in storage and during construction.
- L. Replace damaged materials or equipment as determined by the Engineer at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01610 and as specified.
- B. Packing and Labeling:
 - 1. Firmly attach permanent stainless-steel, or other durable non-corrosive tag to the equipment. Mark tags with the instrument tag number shown in the Instrumentation Data Sheets and/or Instrument Drawings.
- C. Delivery:
 - 1. Provide the packed weights conspicuously shown, and instructions for unloading, transporting, storing, and handling at the job-site.
 - 2. Deliver spare parts at same time as pertaining equipment. Deliver to Owner after completion of work.

D. Storage:

1. The equipment shall not be stored outdoors. Equipment, including in-line equipment, shall be stored in dry permanent shelters, and shall be protected against mechanical damage. Any damaged equipment shall be replaced by the Contractor at his own expense.

E. Handling:

1. Install in accordance with manufacturer's printed instructions, locate as shown on the drawings, and as approved by the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Instrumentation shall be as specified on the instrument data sheets and these specifications.

2.02 FABRICATION INFORMATION:

- A. Mount all panel components to allow easy access for servicing, calibration, adjustments, testing and removal, without the removal of other equipment.
- B. Provide internal panel components mounted directly on removable plates made of the same material and finish as the panel, of a thickness to provide rigid support for mounted components.
- C. Attach identification labels to all internal components.
- D. Unless specified otherwise, pushbuttons shall be of oil-tight, heavy-duty momentary contact pushbuttons, rated for 10 amperes at 120 volts ac unless specified otherwise. Supply with the quantity of poles required for the application.
- E. Unless specified otherwise, rotary selector switches used for controlling 120 volts ac, shall be oil-tight, heavy-duty, maintained contact type rated for 10 amperes at 120 volts ac. Rotary switches used for low level control signals shall have gold or other precious metal contacts rated for "dry contact" duty.
- F. Provide sealed relays DIN rail mounted with indicating light to indicate its' operation. Contacts shall be rated for 10 amperes at 120 volts, ac. Life expectancy shall be 50 million operations, minimum.
- G. Provide electronic timer delay of the plug-in, digital type with output contacts rated for 10 amperes @ 120 volts ac. Life expectancy shall be 20 million operations.

- H. Provide all relays from a single manufacturer.
- I. Power and low-level signal wires shall be routed in separate wireways. Crossings of the two system's wires shall be at right angles. Parallel runs of the two system's wires shall be separated by a minimum of 12 inches.
- J. When required to maintain NEMA integrity, provide louvers, gasketed doors, ventilating fans, and strip heaters. Heater to be rated at twice supply voltage to produce 1/4 of rated heat output.
- K. Provide each NEMA 4X enclosure with sun shades of NEMA 304 stainless steel full size panels mounted 1" from the front top and sides of the panel with stand-off bolts.
- L. Equip heater with thermostat supply switch. Provide thermostatically operated fan. Louvers to be equipped with filters to remove particles to 50 microns.
- M. Provide 16 AWG (1.5 mm), panel wire, type THHN/THWN stranded, and insulated for 600 volts minimum unless otherwise specified.
- N. Provide terminal blocks of corrosion proof material such as nickel plated copper. Provide AC and DC control terminals suitable for 12 AWG (4 mm) or larger wire. Provide terminals for DC analog signals suitable for 16 AWG (1.5 mm) wire.
- O. Provide screw-clamp single level terminals with captive screws; secure the wire connector with a clamp in contact with wire connector. Terminals which secure the wire directly from the screw are not acceptable. Provide all terminal blocks from a single manufacturer.
- P. Provide terminal blocks for every input/output wire. Include terminals for signal cable shields.
- Q. Wire colors shall be assigned as follows; unless supplier has similar color coding standard:

AC Power	Black
AC Neutral or Common	White
AC Control	Red
DC Control	Blue
Equipment or Panel Ground	Green
Externally Powered Circuits	Yellow

- R. Provide shielded cable pairs for all analog signals internal and external to the panels. Provide minimum conductor size of 16 AWG (1.5 mm) for analog wiring internal to the panel.

- S. Terminate all wiring at a central terminal array consisting of rigid terminal strips with numbering identical to the wire numbers. The terminal strips shall contain 25% spare terminals. Arrange the terminal blocks vertically and separate the terminal blocks into functional groups:
 - 1. Group one consists of power wiring.
 - 2. Group two consists of DC signals.
 - 3. Group three consists of alarm/status wiring.
- T. Provide internal wiring troughs of the plastic, open-side type with snap-on covers. The open sides shall permit wire movement without disconnecting it.
- U. Wire connectors shall be the hook-fork type, with non-insulated barrel to allow easy inspection of crimp integrity.
- V. Direct interlock of equipment without auxiliary relaying shall not be allowed.
- W. Use only one side of each terminal block row for internal wiring. Use the other side for field wiring. Do not locate terminal blocks within 6 inches (150 mm) of any right angle panel surface.
- X. Wiring troughs shall not be filled to greater than 60% capacity. Provide snap-on covers marked to identify their locations. Any component identification on the covers shall be repeated on the sub-panel to allow component identification with snap-on cover not in place.
- Y. Provide a plug-in header with flexible leads for instrument power supplies.
- Z. Provide identification for all wiring to panel components powered externally from the panel power circuit breaker inside the panel.
- AA. Identify all relays not provided by others but required for properly providing the control function defined in this section or indicated on the drawings.

An example of this requirement is: ON and OFF pilot lights may be controlled by a single pair of wires from a single contact for both conditions; a relay will therefore be required to provide NO and NC contact for both pilot lights. Such relays shall be mounted in their respective control cabinets, and shall be clearly marked as being powered outside of the panel's normal circuit breaker.

- BB. Provide all instrument power from the instrument panel or termination panel for the control system. Provide power to the instruments from the same panel that receives

the signal. Provide each instrument requiring 120 VAC power or DC power with an individual fused disconnect or circuit breaker. The number of 120 VAC feeds to a panel shall be shown on the electrical drawings. Instrument power shall not be commingled with panel power for other panel devices. Label all devices with circuit numbers or device tag names. Locate current limiting devices in two separated groups within the panel, one group for AC devices and the other group for DC devices.

- CC. For all signals to be transferred to/from another panel, provide current isolators (analog) or dry relay contacts (discrete) wired out to terminal blocks.

2.03 DATA SHEETS:

- A. Data sheets attached to these specifications as 13300-A specify minimum requirements.

2.04 INSTRUMENT CONTROL PANELS:

- A. Provide panels of Type 304 stainless steel or 5052-H32 Aluminum as manufactured by APX Enclosures for non-hazardous locations.
- B. Panels furnished under this section shall be of the design, arrangement, and as specified herein. Access doors (or access panels), shall have stainless-steel hinges, with latching or fastening means fabricated from Type 304 stainless-steel with adequate internal bracing for structural rigidity and strength.
- C. Surfaces containing instruments shall be fabricated from metal not less than 11 gauge Type 304 stainless steel, reinforced to prevent wracking or distortion.
- D. Provide panels with front, rear, sides, and top sections with doors extending the full width for full access to panel-rear mounted components. Provide formed doors of sheet metal with 180 deg. hinges, gasketed to preserve NEMA rating. Provide inside surface of door or removable panel equipped with a drawing pocket to hold as-built and service documentation.
- E. Provide panels with sun shades of NEMA 304 stainless steel full size panels mounted 1" from the front top and sides of the panel with stand-off bolts.
- F. Instruments and accessories mounted, wired or piped to terminal strips or bulkhead fittings, and properly identified to assure ease of field connections.
- G. Provide lamicoid nameplates, White with Black engraved legends attached to the panel surface with stainless steel screws.

- H. Provide in each panel section 120Vac supply fused disconnect switch, duplex service outlet, and switchable 100 watt incandescent lamp with globe and guard. Florescent light shall not be acceptable.

2.05 SPARE PARTS:

A. Spare Parts:

1. Provide spare parts of the type and quantity as specified herein or as specified with the equipment in the attachment A DATA SHEET.
2. Spare parts equal to at least 25% of the field replaceable system components (minimum of one) shall be supplied.
3. All spare parts shall be carefully packed in cartons, labeled with indelible markings, and suitable for prolonged storage. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which part is to be used shall be supplied with the required parts. The spare parts shall be delivered and stored in a location by the Client.
4. Contractor shall provide an itemized price list of the delivered spares for the purchase of additional components. Prices shall be honored for a period of one year from substantial completion of the system.

2.06 SHOP TESTING:

- A. Provide a shop, factory and field test plan outlining the System Supplier's procedures for testing all field primary devices, final control elements, local control panels, control system, PLCs, and termination cabinets at the factory prior to shipment. This plan shall demonstrate the system performs as specified and as indicated. Submit the shop test plan with the shop drawings as specified in paragraph 1.05. Submit results of test to Engineer.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION:

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's printed instructions and approved shop drawings. The locations of equipment, transmitters, alarms and similar devices are diagrammatic only. Exact locations shall be determined by the system supplier during development and fabrication of systems. Obtain in the field, all information relevant to the placing of the process equipment and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials to complete the work

in an approved manner at no additional cost to the Owner.

- B. The drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Provide final equipment interconnections by the system supplier during development and fabrication of systems.
- C. Provide process control system software and hardware configured to achieve the functional requirements as specified herein and as indicated.
- D. Provide uninstalled instruments and spare parts packaged for storage in compliance with Section 01610.
- E. Where specific installation details are not specified or indicated, installation recommendations from the equipment manufacturers or American Petroleum Institute (API) shall be followed as applicable.
- F. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the instrument manufacturer or Engineer but in no case shall more than one ground point be employed for each shield.
- G. Once installed, remove lifting rings from cabinets/assemblies. Permanent plugs shall be provided for the holes of the same material and color as the cabinet.
- H. All work shall be executed in full accordance with codes and these contract documents. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and at no additional cost to the Owner.
- I. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blowdown service shall also be provided.
- J. All piping and tubing to and from field instrumentation shall be provided with unions, calibrations and test tees, couplings, adaptors, and shut off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.
- K. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be rated disconnect

switches or manual motor starters as specified under Division 16.

- L. Provide all brackets, hangers, and miscellaneous metals for mounting of equipment. Mounting hardware shall be installed in accordance with the manufacturers printed recommendations and not interfere with any other equipment.
- M. The system supplier and/or the equipment manufacturer shall provide qualified manufacturer representative to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Owner's approval. Provide on-site services for a minimum period of one 8-hour days, excluding travel time. The system supplier shall certify that all field wiring for power and signal circuits are correctly installed and terminated in accordance with best industry practice and provide for all system grounding to insure a satisfactory functioning installation. The system supplier shall schedule and coordinate work under this section with that of the electrical work specified under applicable Sections of Division 16.

3.02 INSTRUMENT INSPECTION AND CALIBRATION:

- A. Provide letter from instrument manufacturer certifying instrument has been installed based on the manufacturers installation instructions. The letter shall include digital pictures of the installed instrument.
- B. Provide manufactures written calibration procedures that will be used for instrument calibration. Calibrate instrument with calibration tools that conform to NIST traceability chain. Calibration instruments shall be twice as accurate as the instrument being calibrated but as a minimum the calibration instrument shall have a measurement uncertainty of 0.02 percent.
- C. Provide calibration of instruments at 10%, 50%, 80% and 100% of measured span. Provide calibration tag for all calibrated instruments. Provide calibration tag with name, phone number, date and signature of the person and company performing the calibration. Provide linkage or range adjustments sealed by colored lacquer following calibration. Provide calibration documentation like that shown in 13300-B. Provide written calibration records to the engineer prior to substantial completion

3.03 FIELD TESTS:

- A. As a minimum, the testing shall include the following:
 - 1. Operational Readiness Test (ORT).
 - 2. Functional Acceptance Test (FAT).

- B. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied. The system supplier shall provide a detailed step by step test procedure for review and approval by the Engineer.
- C. All tests shall be conducted in accordance with prior Owner and Engineer approved procedures, forms and checklist. Each specific test to be performed and shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.
- D. Signed copies of the test procedures prepared by system supplier, forms and checklists will constitute the required test documentation.
- E. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulation techniques in the test procedures.
- F. The system supplier shall coordinate all testing with the Owner and/or Engineer.
- G. The Owner's and/or Engineer's reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures with no additional cost.
- H. The Owner's and/or Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- I. The system supplier shall furnish the services of field service engineers, all special calibration and test equipment and labor to perform the field tests.
- J. Operational Readiness Test (ORT):
 - 1. General: Prior to the Functional Acceptance Test, the entire system shall be certified (inspected, tested and documented) that it is **READY** for operation.
 - 2. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop by loop and component by component basis by the system supplier following field installation, to demonstrate and document the system is in conformance with related submittals and these specifications. The Contractor is required to confirm that the system is properly wired, terminated and tagged from the field wiring nearest to the primary elements or equipment to the DCS and/or PLC I/O.

3. The system supplier shall maintain the Loop Status Reports and Components Calibration sheets at the jobsite and make them available to the Owner and/or Engineer at all times.
4. The Owner reserves the right to witness and sign off all tests conducted by the system supplier. The Owner shall review and initial all Loop Status Sheets and Component Calibration Sheets and spot check their entries periodically and upon completion of the tests. Any deficiencies found shall be corrected. Final versions of these test sheets shall be submitted to the Owner and/or Engineer at all times.

K. Functional Acceptance Test:

1. Prior to the Functional Acceptance Test, the entire installed instrument and control system shall be certified by the system supplier that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the ORT, ~~and ASORT~~. The intent of the FAT is for all responsible parties, working together, to prove the installed system operates in accordance with the Specifications. Each party is responsible for verifying the completeness of all system components furnished, installed, and configured by their respective firm's or subcontractors.
2. Once the ORT has been completed, a witnessed Functional Acceptance Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these specifications. Each specified function shall be demonstrated on a paragraph by paragraph, loop by loop, and site by site basis.
3. In the event of rejection of any part or function of a system supplier furnished system, the system supplier shall perform repairs or replacement within 10 days and at no additional cost to Owner.
4. Updated versions of the documentation specified to be provided for during the functional acceptance tests shall be made available to the Owner and Engineer at the job sites both before and during the tests. In addition, one copy of all O & M Manuals shall be made available to the Owner and Engineer at the job sites both before and during testing.

3.04 START-UP TESTING:

- A. After completion of the Functional Acceptance Test, the Instrumentation and Control System shall be tested as a component of the Start-up Testing. All furnished hardware and software shall operate for a period of 10 consecutive days, under conditions of full plant process operation, without a single non field repairable malfunction.

- B. During this test, Owner operations personnel and system supplier personnel shall be present as required. The system supplier is expected to provide personnel for this test who have an intimate knowledge of the hardware and the system supplier-provided software of the system. The facilities are not staffed 24 hours per day. Coordinate staffing requirements during the 10-day test to coincide with normal shift operations as much as possible. Off-shift emergencies shall be fully supported by system supplier staff. Provide system supplier staff with cell phones and/or pagers to ensure that support staff is available by phone and/or on-site within four hours of a request by operations staff.
- C. While the start-up testing is proceeding, the Owner shall have full use of the system. Only plant operations personnel shall be allowed to operate equipment associated with live plant processes. Facility operations shall remain the responsibility of the Owner, and the decision of plant operators regarding plant operations shall be final.
- D. During Start-up Testing, the system supplier shall have available, within 4 hours of notification, personnel who have an intimate knowledge of the hardware and system supplier furnished systems.
- E. Any malfunction to system supplier's system during the tests shall be analyzed and corrected by the system supplier. The Owner shall determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- F. Any malfunction attributed to the system supplier during the Start-up Testing which cannot be corrected within 24 hours of occurrence by the system supplier's personnel, or more than two similar failures of any duration, will be considered as a non field repairable malfunction.
- G. Upon completion of repairs by the system supplier, the associated test shall be repeated as specified herein.
- H. In the event of rejection of any part or function, the system supplier shall perform repairs or replacement within 10 days and at no additional cost to the Owner.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

LEVEL SWITCH (FLOAT TYPE) SPECIFICATION

DATA SHEET NO. 853 . 1

GENERAL

1. Tag Number : SEE TABLE BELOW
2. Service : SEE TABLE BELOW
3. P & I D No. : SEE TABLE BELOW
4. Location : SEE ELECTRICAL DRAWINGS

FLOAT

5. Dimensions : APPROX. 6 INCH DIAMETER
6. Material : POLYPROPYLENE

SWITCH

7. Type : MICRO SWITCH STEEL BALL ACTIVATED
8. Contact : SPDT
9. Rating : 5 AMPS AT 120 VAC
10. Enclosure : ENCAPSULATED
11. Open/Close : CLOSE
12. On Level Incr/Decr : INCREASING
13. Output Signal for :
14. Mounting : ADJUSTABLE CLAMP ON 1 INCH STAINLESS PIPE
15. Elec. Class'tion :

PROCESS CONDITIONS

16. Operating Temp. : 40 TO 75 DEG. F.
17. Operating Pressure :

MISCELLANEOUS

18. Interconn. Cable : REQUIRED APPROX. 50 FEET
19. Manufacturer(s) : KARI, NO OR EQUAL
20. Model No.(s) : 170mm, KA SERIES NO OR EQUAL

NOTES

- a. Provide 1-inch diameter SCH 40 316L SS pipe to mount the float switch(s).
- b. Provide KARI level switches as specified. Other manufacturers shall not be accepted based on performance.
- c. Provide detailed instructions for proper installation of switches, enclosures and mounting hardware.
- d. Provide 316 SS brackets and hardware to attach pipe to side of well or tank.
- e. Provide a minimum of 3 brackets spaced a maximum of 10'-0" OC.
- f. Provide all 316 SS mounting hardware to mount float switch(s) to 1-inch pipe. Mounting hardware shall allow for float level adjustment with hand tools.
- g. Provide single sealed well/tank penetration for float switch(s) cables.
- h. Provide 316 SS NEMA 4X or cast aluminum termination enclosure (based on area electrical classification). The enclosure shall provide termination for the float(s) and include isolation

13300-A1

Data Sheet 853 . 1 (CONTINUED)

- relays and intrinsic safety barriers.
- i. Provide termination enclosure mounted on 316 SS UNISTRUT® supports for wall or floor mounting.

<u>TAG NO.</u>	<u>SERVICE</u>	<u>P&ID</u>
LSL - 102	RAW WATER	I-2

LEVEL TRANSMITTER (ULTRASONIC TYPE) SPECIFICATION

DATA SHEET NO. 859 . 1

GENERAL

1. Tag Number : SEE TABLE
2. Service : SEE TABLE
3. P & I D No. : SEE TABLE
4. Location : SEE MECHANICAL DRAWINGS
5. Type : ULTRASONIC, TRANSDUCER

TRANSMITTER

6. Type : ELECTRONIC
7. Display : REMOTE LCD IP65 NEMA 4X
8. Display Units : 4 DIGIT W/ DECIMAL POINT
9. Measuring Range : 6 M (20 FT)
10. Agitator Filters : REQUIRED
11. Input Power : 24 VDC
12. Output : 4 - 20 mADC ISOLATED
13. Resolution : 2.5mm (0.1 INCH)
14. Accuracy : +/- 0.5% OF SPAN
15. Adjustments : DIRECT SETTING BCD IN INCHES
16. Alarms : LOSS OF ECHO AND NEAR ZONE USER CONFIGURABLE FOR HIGH OR LOW LEVEL CURRENT
17. Material : ALUMINUM
18. Mounting : INTEGRAL OR REMOTE
19. Temp : -40° TO 70° C (-40° TO 160°F)
20. Enclosure : IP65 NEMA 4X

TRANSDUCER

21. Enclosure : INTEGRAL OR REMOTE WITH ELECTRONIC UNIT
22. Material : CPVC, PFA
23. Mounting : 50mm (2-INCH) NPT CONDUIT CONNECTION OR FLANGE
24. Beam Angle : 10° AT -3dB
25. Frequency : 53 KHz
26. Temperature Comp : INTEGRAL WITH TRANSDUCER
27. Oper Temp Limts : -40° TO 70°C (-40° TO 160°F) FOR CPVC AND -40° TO 95°C (-40° TO 200°F) FOR PFA.

PROCESS CONDITIONS

28. Operating Temp. : -30° TO 50°C (-20° TO 125°F).
29. Operating Pressure : ATMOSPHERIC

MISCELLANEOUS

13300-A3

MARCO LAKES PUMPS

June 13, 2008

Data Sheet 859 . 1 (CONTINUED)

30. Interconn. Cable : 15M (50 FEET) OR GREATER SO THE
TRANSMITTER CAN BE MOUNTED FOR
OPERATOR ACCESS

31. Manufacturer(s) : E&H, K-TEK, SOLARTROM MOBREY OR EQUAL
NOTES.

- a. Provide all necessary mounting hardware.
- b. Provide detailed instructions for proper installation of sensor, transmitter and mounting hardware.
- c. Provide 316 SS wall sleeve w/ 150mm (6-inch) flange for mounting in top of tanks or wells.
- d. Provide 316 SS (fiberglass for chemical applications) UNISTRUT® floor or wall bracket for indicator or remote mount transmitter.
- e. Provide 12" diameter PVC stilling well mounted on pump pad. Sensor to be mounted within stilling well.

<u>TAG NO.</u>	<u>SERVICE/FLUID</u>	<u>RANGE</u>	<u>P&ID</u>
LE / LT-101	RAW WATER	0-20 FT	I-2

GAUGE PRESSURE TRANSMITTER SPECIFICATION

DATA SHEET NO. 1451 . 1

GENERAL

1. Tag Number : SEE TABLE
2. Service : SEE TABLE
3. P & I D No. : SEE TABLE
4. Location :

TRANSMITTER

5. Type : INTELLIGENT, MICROPROCESSOR BASED
6. Element : CAPACITANCE CELL, RESONANT WIRE OR PIEZORESISTIVE SENSOR
7. Remote Calibration : ZERO AND SPAN VIA HANDHELD TERMINAL, WITHOUT ADDITIONAL HARDWARE, AT ANY TERMINATION POINT IN LOOP
8. Transmittal/Terminal: TWO WAY COMMUNICATION VIA LOOP WIRING SEE NOTE a
9. Self Diagnostics : CONTINUOUS
10. Ambient Temp. Comp. : AUTOMATIC
11. Power Supply : 24 VDC
12. Output Signal : 4 - 20 mADC OR DIGITAL
13. Dir/Rev Acting : DIRECT
14. Turn Down : 6 : 1
15. Span : SEE TABLE
16. Accuracy : +/- 0.1% OF CALIBRATED SPAN
17. Repeatability : +/- 0.05%
18. Local Indicator : REQUIRED
19. Indicator Display : DIGITAL; ENGINEERING UNITS, SIGNAL OUTPUT AND DIAGNOSTICS
20. Bypass Manifold : REQUIRED, 2 VALVE TYPE, 316 SS SEE NOTE b
21. Span (Elev/Suppr) : UP TO 500% OF CALIBRATED SPAN
22. Enclosure : NEMA 4X/IP65/NEMA 7 CLASS I DIV 1 GROUPS A, B, C, D LOCATIONS, AND NONINCENDIVE FOR CLASS I DIV 2, GROUPS A, B, C, D LOCATIONS
23. Elec. Class : SEE ELECTRICAL
24. Mounting : WALL OR PEDESTAL
25. Process Connections : ½ INCH NPT

MATERIALS OF CONSTRUCTION

26. Body : LOW COPPER ALUMINUM
27. Wetted Parts : 316 SS.
28. Fill : SILICON OIL.

13300-A5

Data Sheet 1451 . 1 (CONTINUED)

SERVICE CONDITIONS

- | | | | |
|-----|----------------------|---|-------------------------------|
| 29. | Fluid | : | SEE TABLE |
| 30. | Specific Gravity | : | APPROX. 1.0 |
| 31. | Max. Static Pressure | : | SEE TABLE |
| 32. | Operating Temp. | : | -20 TO 180 DEG. F. SEE NOTE d |
| 33. | Ambient Temp. | : | 0 TO 100 DEG. F. |

MISCELLANEOUS

- | | | | |
|-----|--------------------|---|-----------------------------------|
| 34. | Manifold Manufact. | : | ANDERSON GREENWOOD |
| 35. | Manufacturer(s) | : | ROSEMOUNT, E+H, OR APPROVED EQUAL |
| 36. | Model No.(s) | : | 1151, CERABAR, OR APPROVED EQUAL |

Data Sheet 1451 . 1 (CONTINUED)

NOTES.

- a. Remote communication must not interfere with the analog output signal. Use frequency shift keying (FSK) technique for communication.
- b. Provide standard manifold mounting bracket. Mount the manifold not the transmitter such that the transmitter may be removed for service by removing the four transmitter bolts and disconnecting the signal leads. Provide block/bleed/vent/drain and equal to AGCO M4TP.
- c. Provide block/bleed/vent/drain equal to AGCO M4TP SS body , AMS SS mount and H5VIS-22 drain valve.
- d. Provide 316 SS ½-inch rigid tubing for connection between process measurement primary and process transmitter/manifold. All tubing shall be cut and bent with tube manufacturer approved tools
- e. Provide SS tubing connectors.

<u>TAG NO</u>	<u>SERVICE</u>	<u>FLUID</u>	<u>RANGE</u>	<u>MAX STA PRESS</u>	<u>P&I D</u>
PT-103	RW PUMPS DISCHARGE PRESSURE	WATER	0-150 PSI	120 PSI	I-2

SECTION 15056

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.
- B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.
- C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.
- D. Pipe support locations and types for piping ½ in. and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports ½ in. and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.
 - 1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.
- E. Design and provide all temporary pipe supports required during installation and testing.

1.02 RELATED WORK

- A. Division 1: General Requirements
- B. Section 03300: Cast-in-Place Concrete

- C. Section 09941: Field Painting
- D. Section 15066: Stainless Steel Pipe and Fittings
- E. Section 15101: Process Valves and Appurtenances

1.03 REFERENCES:

- A. American Institute of Steel Construction (AISC) Manual of Steel Construction.
- B. American Society for Testing and Materials (ASTM) Publications:
 - 1. A36: Specification for Structural Steel.
 - 2. A500: Cold formed welded and seamless carbon steel structural tubing.
 - 3. E165: Practice for Liquid Penetrant Inspection Method.
 - 4. E709: Practice for Magnetic Particle Examination.
 - 5. A307: Specification for Carbon Steel Bolts and studs, 60,000 psi Tensile.
 - 6. A312: Seamless and welded austenitic stainless steel pipe.
 - 7. A572: Specification for Steel Plate.
- C. American National Standards Institute (ANSI):
 - 1. ASME/ANSI B31.1: Power Piping Code.
- D. American Welding Society (AWS) Code:
 - 1. Structural Welding Code D1.1.
- E. Manufacturers' Standardization Society (MSS):
 - 1. MSS SP-58: Pipe Hangers and Supports - Materials and Design.
 - 2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 4. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

G. OSHA

1.04 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements as indicated on the structural drawings and as specified herein.

B. It shall be the responsibility of the Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all pipe supports designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate Design, certification signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

1.05 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300 – Submittals:

1. Pipe support drawings specified in paragraph 1.01 and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
 - a. Detailed drawing of the device with dimensions.
 - b. A table of applied forces and moments.
 - c. A complete bill of materials.
 - d. A unique identification and revision level.
 - e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified in paragraph 1.06 E.
 - f. Detailed connections to existing structure.
 - g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1-1.7.

2. Welding Procedure: Submit description as required to illustrate each welding procedure to be performed in the specified work.
3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
5. Pipe support manufacturers' qualifications as specified in paragraph 1.06 E.
 - a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.
 - b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.
6. Coordination drawings for pipe supports shall include as a minimum the following information.
 - a. Coordination drawings shall include all pipe supports covered by specifications 15066, 15370, 15410 and 15806.
 - b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.
 - c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
 - d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4 inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-in. or less in diameter that will be field routed need not be shown on coordination drawings.

- e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections as required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
 - f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.
 - g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
 - h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.
- 7. Written notification of any deviations from the requirements of this specification.
 - 8. Support documentation and justification as specified.
 - 9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports. See Section 01300 for form.

1.06 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified herein.
- B. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.
- C. Structural Concrete: Conform to the requirements of Section 03300. Concrete strength: 4,000 PSI unless noted otherwise.

D. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

E. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.
2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.
3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.
5. Manufacturers' Standardization Society (MSS) Member.
6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

F. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Provide in accordance with Section 01610 and as specified herein.

B. Shipping:

1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

C. Receiving:

1. Inspection and inventory items upon delivery to site.
2. Store and safeguard material in accordance with manufacturers' written instructions.

1.08 SPECIAL REQUIREMENTS

- A. Refer to applicable specification sections of Division 1 and provide the following.
 - 1. Foundations, Installations and Grouting.
 - 2. Bolts, Anchor Bolts, and Nuts.
 - 3. Sleeves and inserts.
 - 4. Protection against electrolysis.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Carpenter & Paterson.
- B. Grinnell Corporation.
- C. Basic Engineers Inc.
- D. Or acceptable equivalent .

2.02 MATERIALS:

- A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.
- B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.
- C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.
- D. Provide only new material. Previously used and/or scrap material is not acceptable.
- E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.
- F. Provide sliding Teflon plates as required. The sliding surfaces shall be a nominal 3/8 in. glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-

cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product .

1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:
2. Tensile strength - 2,000. psi
3. Elongation - 225%
4. Specific Gravity - 2.17 to 2.22
5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.
6. The compressive creep shall be a minimum of 2% at 2,000 psi and 70 degrees F.
7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.

G. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.03 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS

A. Design and provide pipe supports for piping ½ in. and larger to include the following loads:

1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load as required), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.
2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.
4. Wind Loadings: Wind loadings.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

- C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.
- D. Where possible, provide pipe supports, which are the manufacturers' standard products.
 - 1. Provide pipe supports with individual means of adjustment for alignment.
 - 2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.
 - 3. Hanger rods shall be subjected to tension only.
 - 4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
 - 5. Provide concrete inserts capable of supporting the design loads.
 - 6. Metal framing systems will be acceptable to support piping 2 in. and smaller.
 - 7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 in. in length.
 - 8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.
 - 9. Provide supplementary steel as needed.
 - 10. Do not support pipes from other pipe, conduits or metal stairs.
 - 11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.
 - 12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
 - 13. All pipe supports located in fluid flow shall be supplied with double nutting.
- E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.
- F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

- G. Pipe supports connected to structural framing and slabs are subject to the following limitations:
 - 1. Less than 100 lb horizontal load per support.
 - 2. Vertical loads not to exceed a maximum load per hanger of 1000 lbs.
 - 3. For a maximum of one pipe support per foot of slab width perpendicular to the span.
- H. All outside above ground supports shall be Type 316L stainless steel as specified in paragraph 2.02(C).
- I. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.
- J. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.04 FABRICATION:

- A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.
- B. Providing welding in accordance with Structural Welding Code.
- C. Provide dimensional tolerances as specified in MSS-SP-89.
- D. Provide threading and tapping in accordance with MSS-SP-89.

2.05 SHOP PAINTING

- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, minimum of two (2) coats of manufacturers standard high solids epoxy paint (min. 60% solids).
 - 1. Color: As specified for piping system of same service or as selected by the Engineer.
 - 2. Provide similar additional paint for touch-up after installation.
- B. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions.

- C. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.
- B. Perform welding in accordance with Structural Welding Code:
 - 1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of groove welds for throat opening and for snug positioning for back-up bars.
 - 2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
 - 3. Magnetic Particle Inspection: Perform in accordance with ASTM E 709.
 - 4. Liquid Penetrant Inspection: Perform in accordance with ASTM E 165.
 - 5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
 - 6. Test Locations: As selected by the Owner.
 - 7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.
- C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03300.
- D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

- E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.
- F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.
- G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or as required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 in/ 100 ft, for each 100 deg. F change in temperature exceed ½ in., provide sliding supports.
- I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8 in. thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.
- J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.
- K. Apply an anti-seize compound to nuts and bolts on all pipe supports.
- L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Support piping from structural framing, unless otherwise indicated.
- B. Concrete Inserts:
 - 1. Use existing embedded concrete items whenever possible.
 - 2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES:

- A. Thrust Anchors:
 - 1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.

2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS:

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece unless approved by Engineer.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 in. out from face of wall and at least 3 in. below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

- N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.
- O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.
- P. Hanger spacing shall not exceed the spacing listed below:
 - 1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
 - 2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.
- Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.
- R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.
- S. All threads shall be UNC unless otherwise specified.
- T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8 in. fillet weld, 1/2 in. long every 3 inches on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.05 INSULATED PIPING:

- A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.
- B. Where vapor barriers are indicated on water piping, install coated protective shields.

3.06 FIELD PAINTING:

- A. Pipe supports and accessories painted in accordance with Section 09941.

3.07 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 15101

PROCESS VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test valves and appurtenances as indicated and specified.

1. Provide sizes and capacities as indicated or specified.

1.02 RELATED WORK:

A. Section 13300: Utility Control Instrumentation System

1.03 REFERENCES:

A. American Society for Testing and Materials (ASTM):

1. ASTM A48: Specification for Gray Iron Castings.
2. ASTM A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A536: Specification for Ductile-Iron Castings.
4. ASTM B61: Standard Specification for Steam or Valve Bronze Castings.
5. ASTM B62: Standard Specification for Composition Bronze or Ounce Metal Castings.
6. ASTM B98: Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
7. ASTM B271: Standard Specification for Copper-Base Alloy Centrifugal Castings.

B. American National Standards Institute (ANSI):

1. ANSI B2.4: Hose Coupling Screw Threads.
2. ANSI B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

3. ANSI B16.4: Cast-Iron Threaded Fittings, Class 125 and 250.
4. ANSI B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves.

C. American Water Works Association (AWWA):

1. AWWA C500: Standard for Gate Valves, 3 in. through 48 in. NPS, for Water and Sewage System.
2. AWWA C509: Standard Specifications for Resilient-Seated Gate Valves, 3 in. through 12-in. NPS, for Water and Sewage Systems.

1.04 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTALS:

1. Certified shop and erection drawings.
 - a. Electronic files shall conform to the following minimum requirements:
 - (1) Electronic Files: AutoCad R2004 or higher, drawn to scale.
 - (2) Submit electronic files as part of the Shop Drawing submittal.
 - (3) Submit electronic files on CD or DVD
 - (4) Drawings shall include plan views, sectional views, title block, Tag Numbers, serial numbers, Parts List (identifying each component), dimensions, connection sizes and types and all details of all related items. In cases where certain information is proprietary and is omitted, provided a statement indicating that the information is proprietary and is being omitted.
 - b. Drawings shall be in conformance with all other requirements as specified in this specification.
2. Data, regarding valve characteristics and performance including cu.
3. Shop drawing data for accessory items.
4. Manufacturer's literature as needed to supplement certified data.
5. Operating and maintenance instructions and parts lists.

6. Listing of reference installations as specified with contact names and telephone numbers.
7. Valve shop test results.
8. Qualifications of field service technician.
9. Shop and Field inspections reports.
10. List of recommended spare parts other than those specified.
11. Recommendations for short and long term storage.
12. Special tools.
13. Shop and field testing procedures and equipment to be used.
14. Number of service technician days provided and per diem field service rate.
15. Manufacturer's product data and specifications for shop painting.
16. Provide layout drawing showing orientation of plug, gate, check and ball valves and actuator and nearest obstruction.
17. Manufacturer's product data and specifications for shop painting.
18. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
19. The most recent ISO 9000 series certification or quality system plan.
20. Material Certification:
 - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service

conditions specified and indicated.

- B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
 - 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified herein.
- B. Provide enclosures for atmospheres specified and indicated.
- C. Contractor responsible for verifying outside diameter of pipe to be tapped.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01600 and as specified herein.
- B. Shipping:
 - 1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
 - 2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
 - 3. The Contractor shall obtain spare parts from the manufacturer at the same time as pertaining equipment. The Contractor shall maintain possession of spare parts until Substantial Completion, at which time all spare parts shall be turned over to the Owner.
- C. Receiving:
 - 1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts in accordance with manufacturers written instructions.

1.07 SPECIAL REQUIREMENTS:

A. Refer to the applicable sections of Division 1 with regard to providing the following:

1. Lubricants
2. Special Tools
3. Bolts, Anchor Bolts, and Nuts
4. Sleeves and inserts
5. Protection against electrolysis
6. Nameplates
7. Operating and maintenance instructions and parts lists

PART 2 - PRODUCTS

2.01 GATE VALVES 3-INCH AND LARGER

A. General:

1. Provide valves that conform to NSF Standard 61.
2. Non-potable water service: Provide resilient seat gate valves for all sizes indicated. If resilient seat valves are not available provide solid wedge gate valves.
3. Provide metallic seated valves conforming to AWWA C500 except as herein modified. (Valves larger than 48-in. size shall comply with the intent of AWWA C500.)
4. Provide resilient seated valves conforming to AWWA C509 except as modified herein.

B. Materials:

1. Body and Bonnet: ASTM A536 ductile iron
2. Wedge: ASTM A536 ductile iron encapsulated with EPDM

3. Provide all other materials as specified in AWWA C500 and C509.

Working water pressure:

<u>Valve Size</u>	<u>Pressure</u>
3 to 16-in.	250 psi
18-in. and larger	150 psi

4. Exposed valves: Flanged OS&Y valves. Face-to-face dimensions to comply with ANSI B16.10, flanges to comply with ANSI B16.1.
5. Buried valves: Mechanical joint or push-on joint ends, non-rising stem valves with operating nut in lieu of hand wheel. Provide gate boxes, steel extension stems or universal-joint operating rods with 2-in. square operating nuts at upper end with coupling connected to valve stem to bring to operating nut to within 6 inches of ground surface.
6. Provide counterclockwise rotation to open valves.
7. Provide handwheels with arrow and word "open" to indicate open direction.
8. Provide geared operators for all valves 16-in. and larger. Gearing shall be steel with enclosed cases.
 - a. Provide spur gears for buried valves with stems vertical
 - b. Provide bevel gears where required by position of valve.
 - c. Provide buried valves with totally enclosed gear cases to enclose both the gears and valve stuffing box and provide gasketed stainless steel removable cover plates with Type 316 stainless steel fasteners to allow access to the stuffing box.
9. Chainwheels: Provide where required as specified herein. Provide beveled gear operator to mount chainwheel in vertical position. Provide valve mounted so that the arrow indicator will be visible from the floor level.
10. Provide conventional packing in OS&Y valves.
11. Provide conventional packing or double O rings in non-rising stem valves.
12. Valves capable of being repacked or O ring replaceable while under pressure.
13. Provide Type 316 stainless steel bolts and bronze nuts for stuffing box follower.

14. Provide bypass valves for valves 16-in. and larger where required for opening under pressure with a maximum 40-lb rim pull at the valve pressure rating.
- C. Provide all gate valves with all internal and external wetted parts coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550.
- D. Solid Wedge Gate Valves:
 1. Manufacturers:
 - a. ARD
 - b. Or acceptable equivalent product
- E. Double Revolving Disc Gate Valves:
 1. Manufacturers:
 - a. ARD
 - b. Or acceptable equivalent product
- F. Resilient Seat Gate Valves:
 1. Manufacturers:
 - a. US Pipe
 - b. American Cast Iron Pipe
 - c. Kennedy Valve
 - d. Mueller
 - e. Seguro Valve
 - f. Or acceptable equivalent product

2.02 PUMP CONTROL AND PRESSURE REDUCING VALVE

- A. Provide a pump control and pressure reducing valve that shall minimize pump starting and stopping surges by placing the pump 'on line' and taking it 'off line' slowly, and reduce a high incoming pressure to a lower, constant discharge pressure regardless of variations in upstream pressure or flow rate.

- B. Solenoid valve shall be four-way de-energized to close valve, with a 120VAC/ 60Hz solenoid coil.
 - 1. Provide a manually adjustable pilot provided with isolation valves.
 - 2. Valve and piping: Type 316 stainless steel.
- C. The Pressure Reducing Pilot will maintain downstream pressure.
- D. Valve shall include internal drop check valve to prevent reverse flow back through the valve.
- E. Manufacturers:
 - 1. Singer Model S106-BPC-PR-SIV
 - 2. Or acceptable equivalent product
- F. Main Valve:
 - 1. Valve(s) shall be a hydraulically operated globe valve. The inner valve assembly shall be top and bottom guided by means of easily replaceable bearing bushings. The inner valve assembly shall be the only moving part and shall be securely mounted on a 316 stainless steel stem.
 - 2. Valve body and caps: Ductile iron ASTM A536-84
 - 3. All pressure containing components shall be constructed of ASTM A536-65/45/12 ductile iron. The flanges shall be designed to ANSI Class 150 standards. Flange drilling to ANSI shall be standard.
 - 4. Valve(s) shall have a protective fusion bonded epoxy coating internally and externally. The protective fusion bonded epoxy coating shall conform to the ANSI/AWWA C116/A21.16 (current version) specification.
 - 5. Valve(s) 10" (250mm) and larger shall provide smooth "frictionless" motion and maximum low flow stability with actuation. The diaphragms shall not be used as a seating surface. No lip seals or packing may be used to seal the actuator.
 - 6. The valve cover shall have a separate stem cap giving access to the stem for alignment check, spring installation and ease of assembly.
 - 7. The valve(s) shall form a drip tight seal between the stationary stainless steel seat ring and the resilient disc, which has a rectangular cross-section and is retained by clamping on three and one half sides. The resilient disc shall be constructed of

Buna or EPDM for normal service conditions.

8. All repairs and maintenance shall be possible without removing the valve from the line. To facilitate easy removal and replacement of the inner valve assembly and to reduce unnecessary wear on the guide, the stem shall be vertical when the valve is mounted in a horizontal line.
9. Each valve shall be tested prior to shipment. The standard test shall include a pressure test and a full functional, operational test when pilots and accessories are fitted to suit a particular application.
10. Bronze parts: ASTM Specification B-62.
11. Stainless parts: ASTM Specification A743 Grade CF-8M.
12. Teflon coated parts shall receive two coats of Teflon TFE with a total minimum thickness of 10 mils.
13. The flanged assemblies shall conform to ANSI standards for wall thickness of body and caps, and flange thickness and drilling.

G. Valve Shop Testing:

1. Hydrostatically test valve tested at two (2) times the working pressure, maximum 500 psi at the factory prior to painting and shipment.
2. Performance test the valves at the specified conditions.
3. All tests will be witnessed by the Engineer.

H. Coat ferrous surfaces of valve with NSF Certified Epoxy (Tnemec Series FC20) in accordance with ANSI/NSF Std. 61, and in conformance to AWWA D102 Inside System No. 1.

2.03 AIR RELEASE VALVES:

A. Manufacturers:

1. Crispin
2. Val-Matic
3. Or acceptable equivalent product.

- B. Valves: Provide air release valves of the automatic float operated type designed to release accumulated air from a piping system while the system is in operation and under pressure.
- C. Provide valves manufactured and tested in accordance with AWWA C512.
- D. Valve manufacturer must have a quality management system that is certified to ISO 9001:2000 by an accredited, certifying body.
- E. Provide valves with the cover bolted to the valve body and sealed with a flat gasket.
- F. Provide replaceable resilient seats
- G. Provide drop tight shut off to the full valve pressure rating.
- H. Provide floats guaranteed against failure including pressure surges.
- I. Mechanical linkage to provide sufficient mechanical advantage so that the valve will open under full operating pressure.
 - 1. Simple lever designs: Provide valves consisting of a single pivot arm and a resilient orifice button.
 - 2. Compound lever designs: Provide valves consisting of two levers and an adjustable threaded resilient orifice button.
- J. Provide valve body with threaded NPT inlets and outlets.
 - 1. Inlet Connection: Provide hexagonal for a wrench connection
 - 2. Working Pressure: 100 psi
 - 3. Provide valves with two (2) additional NPT connections with ball valves as specified herein, one connection with a plug and one with a hose coupling for the gauges, testing, and draining.
 - 4. Provide a vacuum check on the outlet to prevent air from re-entering the system during negative pressure conditions.
- K. Materials:
 - 1. Valve Body, Cover and Baffle:
 - a. ASTM A351 Grade CF8M stainless steel

2. Floats, Orifice and linkage: Type 316 stainless steel, non-metallic components are not acceptable.
3. Orifice Button: Viton for simple lever valves and Buna-N for compound lever designs
4. Hardware: Type 316 stainless steel
5. Screened Hood: Type 316 stainless steel

L. Testing:

1. Test valves at 1.5 times the rated working pressure

M. Painting:

1. Painting Primer and Finish Paint: Shop apply to all exterior ferrous surfaces manufacturers standard paint.
 - a. Solids by Volume: Minimum 57% (percent ± 2).
 - b. Type: Polyamide epoxy, self priming.
 - c. Dry Film Thickness: 4 to 6 mils per coat.
 - d. No. of Coats required: Two.
 - e. V.O.C Requirement: 3.06 lbs/gallon.
 - f. Conform to AWWA D102 Inside systems No.1 and No.2.
 - g. Use thinners that are acceptable to ANSI NSF Std 61.
 - h. Color: Red or as selected by the Engineer.
2. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions.

2.04 PAINTING:

- A. Coat internal and external ferrous surfaces of valve with NSF Certified Epoxy in accordance with ANSI/NSF Std. 61, and in conformance to AWWA D102 Inside System No. 1 for all valves not specified to have a fusion bonded epoxy coating.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.
- C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.
- D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.
- E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.
- F. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as indicated and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

3.02 GATE VALVES:

- A. Install gate valve stem as indicated or with stems between vertical and 45 degrees above the horizontal. Valves installed with stems below horizontal are not acceptable.

3.03 CHECK VALVES:

- A. Install swing check valves horizontally in pipelines.

3.04 PLUG VALVES:

- A. Install valves in horizontal piping with shaft horizontal such that in open position, plug is located in upper part of valve body. Orient valves so that in closed position, flow is against the face of the plug.

3.05 FLOORSTAND OPERATORS AND STEM GUIDES:

- A. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if to suit actual conditions of installation.

3.06 VALVE BOXES:

- A. Provide valve box for each buried valve and where indicated.
- B. Set box so top is flush with finished surface and so box does not bear on valve, or pipe.

3.07 FIELD PAINTING:

- A. Furnished and applied by Painting Subcontractor as specified.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 15370

PROCESS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test process pipe, fittings, and appurtenances as indicated and specified.

1.02 RELATED WORK:

- A. Section 01171: Electric Motors
- B. Section 02615: Ductile-Iron Pipe and Fittings
- C. Section 11303: Solids Handling Pumps and Appurtenances
- D. Section 11301: Vertical Turbine Pumps and Appurtenances
- E. Section 13300: Utility Control Instrumentation System
- F. Section 15056: Pipe Supports
- G. Section 15101: Process Valves and Appurtenances

1.03 REFERENCES:

- A. American Welding Society: AWS B3.0
- B. Manufacturer's Standardization Society: MSS SP-69
- C. American Society for Testing and Materials:
 - 1. ASTM A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
 - 2. ASTM A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
 - 3. B75: Specification for Seamless Copper Tube
 - 4. B88: Specification for Seamless Copper Water Tube
 - 5. B16.15: Standard for Cast Bronze Threaded Fittings, 125 and 250 lb

6. B16.18: Standard for Cast Copper Alloy Solder-Joint Pressure Fittings
7. B16.22: Standard for Wrought Copper and Bronze Solder-Joint Pressure Fittings
8. B16.26: Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
9. ASTM D1330: Standard Specification for Rubber-Sheet Gaskets

D. American National Standards Institute:

1. ANSI B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
2. ANSI B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

E. Fluid Sealing Association - Technical Handbook.

F. Expansion Joint Manufacturers Association Standards.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01300:

1. Submit manufacturer's certificates of conformance.
2. Submit certified copies of test reports.
3. Piping layouts in full detail.
4. Location of pipe hangers and supports.
5. Location and type of backup block or device to prevent joint separation.
6. Large scale details of wall penetrations and fabricated fittings.
7. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.
8. Reports as required for welding certifications per ANSI B31.1 Paragraph 127.6.
9. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
10. Brochures and technical data on coatings and linings and proposed method for application and repair.

11. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.
 12. Shop drawing data for accessory items.
 13. Manufacturer's literature as needed to supplement certified data.
 14. Operating and maintenance instructions and parts lists.
 15. Schematic control and power wiring diagrams.
 16. Shop and Field inspections reports.
 17. List of recommended spare parts other than those specified.
 18. Recommendations for short and long term storage.
 19. Special tools.
 20. Shop and field testing procedures and equipment to be used.
 21. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.
 22. The most recent ISO 9000 series certification or quality system plan.
 23. Material Certification:
 - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and as indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified. And indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Authority.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.
- 1.05 QUALITY ASSURANCE:
- A. Provide in accordance with Section 01400 and as specified.
 - B. Replace all materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner, and acid solder at no additional cost to the Owner.
 - C. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.
 - D. Qualification for Pipe Support Structural Attachment Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
 - E. Protect piping from dirt, dust, oil, grease, and other foreign matter during installation to prevent debris from being left in piping.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01610 and as specified.
- B. Shipping:
 1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. The Contractor shall obtain spare parts from the manufacturer at the same time as pertaining equipment. The Contractor shall maintain possession of spare parts until Substantial Completion at which time, all spare parts shall be turned over to the Owner.

C. Receiving:

1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, material and spare parts in accordance with manufacturer's written recommendations and instructions.

1.07 SPECIAL REQUIREMENTS:

- A. Refer to the applicable specification sections of Division 1 with regard to providing the following:
 1. Lubricants.
 2. Special Tools.
 3. Bolts, Anchor Bolts, and Nuts.
 4. Sleeves and inserts.
 5. Protection against electrolysis.
 6. Nameplates.
 7. Operating and maintenance instructions and parts lists.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS:

- A. Provide in accordance with Section 02615.

2.02 STAINLESS STEEL PIPE AND FITTINGS ½-INCH TO 2-INCH:

- A. Provide either Pressfit or a socket welded system.
 1. Provide a sufficient number of unions to allow removal of all valves and inline devices.

2. Provide threaded connections only where required.

B. Pressfit System:

1. Pressfit system, ½-inch through 2-inch Sch 5S comprised of stainless steel Pressfit fittings, couplings and pipe.
2. Type 316 stainless steel Pressfit couplings and fittings and Type 316 stainless steel Pressfit pipe UL classified to ANSI/NSF 61 for cold +86 degrees F (+30 degrees C) and hot +180 degrees F (+82 degrees C) potable water service.
 - a. Maximum working pressure of 300 psi for water, oil, gas, chemical, air and vacuum services.
3. Couplings, Fittings: Pressfit products formed of Type 316/316L stainless steel tubing including a self-contained o-ring seals molded of synthetic EPDM rubber.
4. Valves ½-in through 2-in: ball valves with Type 316 stainless steel plain ends for Pressfit assembly.
 - a. Pressure Rating: 300 PSI
 - b. CF8M stainless steel body and ball
 - c. Type 316 stainless steel stem
 - d. PTFE seats.
5. Pipe: Type 316/316L ASTM A-312 stainless steel
 - a. 0.065 wall
 - b. Provide pipe fully finished annealed with polished O.D.

C. Socket Welded System:

1. Schedule 40 Type 316L stainless steel pipe and fittings with socket welded connections.

2.03 PRESSURE GAUGES:

A. Gauges:

1. Non-liquid filled type.
2. Helical wound bourdon tube, Inconel X-750.

3. Welded parts: Type 316 stainless steel.
 4. Bearings: Precision Sapphire Type.
 5. 1/2-in NPT bottom male thread connection.
 6. Accuracy: 1/2 percent of scale range.
 7. 4 -1/2-inch diameter with ABS plastic case.
 8. Provide external adjustment.
 9. Pipe and Fittings: Schedule 5 Pressfit or Schedule 40 threaded or socket welded, Type 316L stainless steel.
 10. Pump Discharge Gauges: Provide gauges with range to cover the normal operating range, above the pump shutoff head and the range of pressures that will result from flushing.
- B. Pipe and fittings: Type 316L stainless steel, provide in accordance with Section 15370
- C. Ball valves: General service ball valves, stainless steel in accordance with Section 15101.
- D. Pressure Sensor Rings:
1. 1-in and Larger: Provide sensor/isolators that fit inside the bolt circle of 150-lb or 300-lb ANSI flanges as required.
 2. 3/4-in and Smaller: Provide sensor/isolators full flange or threaded as specified and indicated. For chemical system provide full flange, threaded connections are not acceptable.
 3. Face to face length of the sensor: Conform to Specification MSS-SP67.
 4. Type: Flow through design with flexible sleeve around full circumference. The center section shall have a cavity behind the sleeve filled with silicone fluid to transfer pressure to the gauge.
 5. Rigidly support all pressure instruments by a post at least 7/8 in. diameter welded to the isolator. On sensor rings with more than one instrument, provide all connections 1/2-in. NPT as a minimum, 1/4-in. NPT fittings are not acceptable.
 6. Provide sensor/isolator rings that do not have any fill plugs or valves that can be inadvertently removed with the resultant loss of fill fluid. Pressure sensor/isolators using valves are not acceptable.

7. Provide liquid filled sensor/isolators permanently vacuum sealed at the factory with a modular seal consisting of a membrane and needle fitting to allow removal and replacement of pressure instruments without compromising the vacuum fill. Sensor/isolators using valves are not acceptable.
8. Provide the needle fitting with both 1/4-in. NPT(F) threads and 1/2-in. NPT(M) threads.
9. Provide the pressure sensor/isolator capable of operating under pressure with all pressure instruments removed with no loss of fill fluid and without the need for isolating valves.
10. Attach pressure instruments to the isolator with a hand tightened lock ring.
11. It shall be possible to remove or attach pressure instruments to the isolator without requiring the use of any tools.
12. Permanently fill the pressure sensor with high viscosity silicone instrument oil to damp out surges or pressure spikes without the requirement for a separate snubber.
13. Pressure rating: 200 psi minimum for all lines tested at 150 psi or less and 600 psi minimum per lines tested above 150 psi.
14. Provide gauges as specified herein. Provide all other types of instruments indicated and specified in accordance with Section 13300.
15. Materials:
 - a. Pressure sensor/isolator rings: Provide materials suitable for the service conditions specified and indicated, as a minimum provide the following

Service	Body & Plates	Sleeve
Water	Type 316L Stainless Steel	Natural Rubber

2.04 PRESSURE AND FLOW INSTRUMENTATION:

- A. Provide in accordance with Section 13300.

2.05 COUPLINGS-BOLTED SPLIT SLEEVE TYPE:

- A. Type: Bolted, split-sleeve type coupling consisting of four basic components; one piece housing, gaskets assembly, bolts and nuts, and restraint rings as required for restraint.
 1. Provide split-sleeve with a double arch cross section closing around pipe ends that are smooth for expansion or contraction requirements or pipe ends with end rings affixed for pipe end restraint requirements. As the coupling housing closes, it

confines the elastomeric gasket beneath the arches of the sleeve to create the radial seal. The axial seal is affected by the sealing plate at the closure plates as the bolts pull the coupling housing snug around the pipe.

2. Provide sealing members comprised of two “O” ring gaskets and an elastomer sealing pad bonded to the integral sealing plate.
- B. Provide couplings designed for the type, size, and working pressure of the piping system as indicated in the Process Piping Schedule and specified.
- C. Materials:
1. Split-sleeve:
 - a. Carbon Steel and Ductile Iron pipelines: ASTM A-36 Carbon Steel.
 - b. Stainless steel pipelines, ASTM A-240 Type 316L stainless steel.
 2. Gaskets:
 - a. Material: Elastomers in accordance with ASTM D-2000.
 - (1) Air Service: Silicone conforming to ASTM D-2000 for air service up to 240° F. with intermittent exposure to 280° F.
 - (2) Liquid Service: Isoprene or Buna-N conforming to ASTM D-2000 for service within the temperature range of -20° F to 180° F.
 3. Bolts and Nuts:
 - a. Bolts: Stainless steel conforming to ASTM F593 Type 316, minimum tensile strength 85,000 p.s.i. (or threaded studs to ASTM A-193, Class 2 Grade B8M Type 316)
 - b. Nuts: ASTM F593 Type 316.
 4. End Rings:
 - a. Provide restraint rings of the same material as the coupling housing.
 - b. Non-restrained (ExE) type couplings allows for up to 4 degree deflection. Provides for coupling joint where restraint is not required. If restraint is required, it must be provided independent of the coupling.
 - c. Fixed x Expansion (FxE) type couplings: Allows for thermal expansion and contraction at the pipe joint. Provide one or two restraint rings fixed to one end of the pipe to keep coupling in the proper location. Where split sleeve coupling

FxE for expansion is used provide the expansion side of the coupling with a combination of fixed and sliding supports for thermal movement.

- d. Fixed x Fixed (FxF) type couplings: Provides a fully restrained pipe joint. Provide one restraint ring welded to each of the pipe ends fitting beneath the coupling to prevent the pipe joint from pulling apart.
 - e. Provide type as indicated and specified.
 - f. Follow manufacturer's written recommendations and instructions for location dimensions and welding detail required to attach the restraint rings.
- D. Protective Coating: Prior to installation, couplings shall be coated on the I.D. and O.D. in accordance with section 09940 and 09941.
- E. Couplings installed underground: Provide bitumastic coating or joint tape wrap.
- F. Installation of couplings shall be in accordance with manufacturer's recommendation.
- 1. The coupling housing shall be assembled pulling the closure plates together with the bolts tightened to assure snug coupling housing contact with the pipe OD. Follow the manufacture's recommendation regarding the installation and tightening of the bolts.

2.06 EXPANSION JOINTS-STAINLESS STEEL:

A. Manufacturers:

- 1. Pathway
- 2. Flexonic
- 3. Adsco
- 4. Or acceptable equivalent product.

B. Design Criteria:

- 1. Liquid: Service as indicated in the Process Pump Schedule.
- 2. Liquid Temperature: As indicated in the Process Pump Schedule.
- 3. Minimum Pressure Rating: 150 psi minimum or as indicated in the Process Piping Schedule.
- 4. Minimum Lateral Movement: 0.125-inch.

5. Minimum Axial Movement: 0.4-inch
6. For expansion joints used on pump discharge nozzles the Contractor shall coordinate the rod size and movement allowable with the pump manufacturer and provide a statement from the pump manufacturer that the expansion joint and rod size is acceptable for the pump provided.

C. Products:

1. Provide bellows of two ply construction formed from concentric tubes having only longitudinal seams.
2. For two ply construction, each ply shall be capable of retaining the rated pressure at the specified temperature independently.
3. For two ply construction, seal weld both plies so that no gas or liquid leaks out at the ends.
4. For two-ply construction, provide a pressure monitoring connection with pressure gauge and pressure switch as specified herein for the annular space.
5. Provide control rods for test pressure.
6. Provide minimum two lifting lugs on each joint. Each lug shall be designed to carry the entire weight of the assembly.
7. Provide each joint with a liner and mark a flow arrow on the outside to indicate direction of flow.
8. Provide each expansion joint with a Type 316 stainless steel nameplate indicating size, bellows material, pressure and temperature rating, lateral and axial limits on movement, date of manufacturer, and the manufacturer.

D. Materials:

1. Bellows:
 - a. Inner Ply: Inconel alloy 625, minimum 0.048-inch thick.
 - b. Outer Ply: Inconel alloy 625, minimum 0.048-inch thick.
2. Liner: Type 316L stainless steel, minimum 0.1875-inch thick.
3. Flanges: Type 316L stainless steel, Class 150.
4. Limit Rods/Nuts and Hardware: Type 316 stainless steel.

E. Install joints in their neutral position.

2.07 WALL AND FLOOR SLEEVES:

A. Materials:

1. Floor Sleeves:

- a. 3-in. and Smaller: Schedule 40 Galvanized steel ASTM A53 GRB
- b. 4-in. and larger: Ductile iron in accordance with Section 02615

2. Wall Sleeves Between a Dry Area and a Wet Area (Tank, Channel etc)

- a. Schedule 40 Type 316L stainless steel

3. Wall Sleeves Between Dry Area or Between Dry Area and Ground

- a. 3-in. and Smaller: Schedule 40 Galvanized steel ASTM A53 GRB
- b. 4-in. and larger: Ductile iron in accordance with Section 02615

B. Water Stops: Provide water stops welded on both sides. Provide water stops 1/4-in. thick and 2-in. high and centered on the wall thickness.

C. Provide modular, mechanical type seals, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

D. Provide the elastomeric elements sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.

E. Temperature Range: -40 to +250°F

1. Material: EPDM, ATSM D2000 M3 BA510

2. Color: Black

F. Modular seal pressure plates: Molded of glass reinforced Nylon Polymer with the following properties:

Izod Impact – Notched: 2.05ft-lb/in. per ASTM D-256

1. Flexural Strength @ Yield: 30,750 psi per ASTM D-790

2. Flexural Modulus: 1,124,000 psi per ASTM D-790

3. Elongation Break: 11.07% per ASTM D-638

4. Specific Gravity: 1.38 per ASTM D-792

G. Hardware: Type 316 stainless steel.

PART 3 – EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Ensure interior lines parallel to building walls wherever possible. Install piping to accurate lines and grades, and support. Provide pipe supports as specified under Section 15056 except runs of PVC piping. Where temporary supports are used, ensure rigidity, to prevent shifting or distortion of pipe. Provide for expansion.
- C. Support piping laid in trenches in trench on bed of selected backfill material which maintains desired line and grade.
- D. Pitch all piping toward low points. Provide for draining low points.
- E. Before assembly, remove all dirt and chips from inside pipe and fittings.
- F. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.
- G. Welding in accordance with AN Standard B31 and AWS B3.0.

3.02 WALL SLEEVE SEALS:

- A. Expand rubber against pipe and sleeve by tightening bolts when assembled around pipe and inserted in wall.

3.03 TEMPORARY PLUGS:

- A. Close open ends of pipe with temporary plugs or caps when pipe installation is not in progress. Use watertight plugs for exterior, buried piping and if water or debris is in trench when work is resumed, do not remove until adequate provision has been made to prevent any water or debris entering pipe even if it necessitates dewatering trench.

3.04 TESTING:

- A. After installation, test all pipelines for watertightness. Furnish testing plugs or caps, pressure pumps, pipe connections, gauges, all equipment, all labor, and all water.

- B. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.
- C. Test pressures as indicated in Process Pipe Schedule.
- D. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.

3.05 FIELD PAINTING:

- A. Furnished and applied by Painting Subcontractor.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16050

ELECTRICAL WORK - GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete and operational systems for electric power systems, grounding systems and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all work and testing as indicated and specified.
 - 1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.
 - 2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction of proposed electric system. Perform work at the convenience of the Owner.
 - 3. Raceways supports and equipment anchoring shall be provided as specified in the Division 16 sections which form a part of the Contract Documents.
 - 4. Electrically powered equipment and devices provided under other divisions and sections of the specifications are connected to the project specified electrical systems as part of the Electrical Work. Refer to Paragraph 1.02 - Related Work.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Division 11: Equipment
- C. Division 13: Special Construction
- D. Variable frequency drive (VFD) units shall be furnished to the Contractor by the City as part of the pump package, installed by the Contractor, and tested by the VFD supplier . All associated conduit, wire, and terminations of the VFD units shall be provided under the electrical sections. Refer to separate specification package for pump and VFD.
- E. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract and is specified under Section 02050. This includes relocation of

junction box and conduit for the existing lake level transmitter.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01300 - Submittals:

1. Shop Drawings and Data: Include manufacturer's drawings, bills of material, panel and equipment layouts, catalog data, schematics diagrams, interconnection diagrams, wiring diagrams and other documentary or descriptive information as required for each assembly submitted in one package insofar as possible.
 - a. Bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
 - b. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.
 - c. For informational purposes only, submit equipment installation instructions in separate submittals from other shop drawings.
 - d. Shop drawings and data are required for the following list:
 - (1) Conduit and Fittings
 - (2) Wire and Cable
 - (3) Circuit Breakers for the existing Cutler Hammer switchboard, including mounting, filler plates and lugs required
 - (4) Wiring Devices
 - (5) Handholes, and Associated Equipment and Devices
 - (6) Grounding Equipment and Devices
 - (7) Panelboards
 - (8) Lighting Fixtures and Accessories
 - (9) Control Stations
 - (10) Enclosures

(11) Control Panels

(12) Field Acceptance Test Reports

(13) Record Drawings

- e. Mark shop drawings and data submitted showing only items applicable to specific contract.
- f. Include one-line diagrams, schematic diagrams, wiring diagrams, control sequence diagrams, relay diagrams, and metering. Submit only completed drawings showing all local and remote devices associated with each item. Submit one complete package of shop drawings. Partial submittals will be returned without action.
- g. Install permanent nameplates on all devices or pieces of equipment such as circuit breakers, VFD's, relays, contactors, pushbuttons, indicating lights, and switches. Ensure position of nameplates readable after equipment installation.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified.
- B. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and with requirements of the City of Marco Island.

1.05 INTERFERENCE AND ERRONEOUS LOCATIONS:

- A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
- B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.
- C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.06 APPROVAL AND MARKING EQUIPMENT:

- A. Insure that devices and materials are listed and/or labeled by Underwriters' Laboratories, Inc., wherever standards have been established by that agency. Where Underwriters' Laboratories listing is not available for equipment, submit certified test reports of Nationally Recognized Testing Laboratory, approved by the local inspecting authority, indicating that equipment is in conformance with local code

requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.

- B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.08 ELECTRIC SERVICE:

- A. Electrical power system for the facility operates at 480/277-volt, 3-phase, 4-wire, 60-Hertz.
 - 1. Electrical low voltage distribution system operates on 208/120 volt, 3-phase, 60-Hertz obtained from the power system by dry-type transformer(s).
- B. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work is included under this section and shall conform to requirements specified under applicable sections of Contract for General Construction.

1.09 EQUIPMENT SPECIFIED ELSEWHERE:

- A. Certain items of control equipment and other equipment are indicated on electrical drawings for connection, but are specified in other sections pertaining to mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT:

- A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, boxes, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.
- B. Remove from site and dispose of material and equipment not indicated for reuse.

3.02 PROTECTION OF ELECTRICAL EQUIPMENT:

- A. When an electrical shutdown is necessary, notify the Owner stating when shutdown is wanted, work planned during shutdown, and estimated shutdown time.
- B. Plan work to minimize shutdown. Before starting, have equipment to be used unpacked, checked for damage, and checked dimensionally to ensure proper fit.

3.02 PROTECTION OF ELECTRICAL EQUIPMENT:

- A. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction. Do not store equipment outdoors. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.03 DEFECTIVE OR DAMAGED EQUIPMENT:

- A. Thoroughly dry out equipment or material subjected to possible water damage, and put through special dielectric test as directed, without additional cost to Owner.

3.04 EQUIPMENT ENCLOSURE:

3.05 DRAWINGS AND SPECIFICATIONS:

- A. Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.
 - 1. At the completion of the project, provide two sets of drawings that are marked to show the as-installed equipment, devices, ductline locations and wiring. These sets are to be provided to the Owner. The markings on the drawings are to be neat, clean and legible.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16110

ELECTRICAL RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete raceway systems, with matching accessories, fittings, boxes, and other hardware, as indicated and specified. Provide green insulated grounding conductor sized per NEC requirements.
- B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.
- C. Provide raceway systems in accordance with the following:
 - 1. In NEMA 12 or NEMA 1 areas, use galvanized rigid steel raceway systems.
 - 2. In NEMA 4 areas, and where subject to wetting or wash down, use PVC coated rigid steel raceway systems.
- D. All raceway systems shall be installed in accordance with the criteria described in this section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.
 - 1. Use Type 316 stainless steel support systems.
- E. Aluminum conduit and boxes are not acceptable products.
- F. All raceways shall be supported to National Electrical Code requirements.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General
- B. Section 16402: Underground Distribution System

1.03 REFERENCES:

A. National Fire Protection Association (NFPA):

1. National Electrical Code (NEC)

B. Underwriter's Laboratories, Inc. (UL):

1. U.L.-1: Electrical Flexible Metal Conduit
2. U.L.-6: Rigid Metal Electrical Conduit
3. U.L.-360: Electrical Liquid-Tight Flexible Steel
4. U.L.-651: Schedule 40 and 80 PVC Conduit
5. U.L.-886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C, and D and Class 11, Groups E, F, and G
6. U.L.-1242: Intermediate Metal Conduit

C. National Electrical Manufacturers Association (NEMA):

1. RN-1: Polyvinylchloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
2. TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01300 - Submittals:

1. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 16050.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01400.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S:

MARCO LAKES PUMPS

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A. Rigid Metal Conduit, and polyvinylchloride-coated rigid steel conduit.

1. Triangle/PWC, Inc.
2. Perma-Cote Industries.
3. Republic Steel Corporation.
4. Robroy Industries.
5. Allied Tube and Conduit.
6. Or acceptable equivalent product.

B. Polyvinylchloride (PVC) Conduit:

1. Triangle/PWC, Inc.
2. Robroy Industries.
3. Carlon Electrical Sciences, Inc.
4. Or acceptable equivalent product.

C. Flexible Conduit:

1. American Flexible Conduit Company.
2. Anamet, Inc.
3. Electri-Flex Company.
4. International Metal Hose Company.
5. Or acceptable equivalent product.

D. Boxes and Fittings:

1. O.Z./Gedney Company.
2. Crouse-Hinds Electrical Construction Materials.
3. Appleton Electric Company.
4. Or acceptable equivalent product.

E. Support Systems:

1. Michigan Hanger Co., (O-Strut).
2. Thomas & Betts (Superstrut).
3. Unistrut Corp.
4. Or acceptable equivalent product.

2.02 MATERIALS AND COMPONENTS:

A. Rigid Metal Conduit:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.
2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to U.L.-6.

B. Flexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to U.L.-1.
2. Provide liquid-tight flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. Provide stainless steel, braided flexible conduit in NEMA 4X, corrosive areas. On larger than 1-1/4-in., furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to U.L.-360.

C. Polyvinylchloride (PVC) Conduit:

1. Provide PVC conduit, Schedule 40 conforming to NEMA Standard TC-2 and UL-651.

D. Polyvinylchloride-Coated Rigid Steel Conduit:

1. Provide polyvinylchloride-coated (PVC-Coated), rigid steel conduit conforming to NEMA Standard RN-1 consisting of hot-dipped galvanized rigid steel conduit, as specified hereinbefore, with a polyvinylchloride jacket bonded to the outside of all conduit surfaces with a nominal thickness of 40

mils meeting the requirements of NEMA RN-1, 3.1. The adhesive strength of the bonding to equal or exceed tensile strength of the coating. Provide couplings and fittings for this conduit conforming to the requirements of NEMA RN-1, 3.5.

2. A two-part urethane coating shall be applied to the interior of all conduit and fittings at a two mil thickness. The interior coating shall be flexible to allow field bending without cracking or flaking.

E. Boxes:

1. In NEMA 3R areas provide approved boxes.
2. In NEMA 1 and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box as required by the NEC.
3. Provide boxes and covers for polyvinylchloride-coated steel conduit made of galvanized cast iron, with a polyvinylchloride factory-applied coating over the galvanizing. Provide coating thickness of 40- mil minimum. Boxes shall have hubs with extruded sleeves extending beyond the hub in the same manner as specified for conduit couplings. Provide cover screws of stainless steel.
4. Provide cast boxes with covers or device plates suitable for the area classification. Use cover screws of stainless steel or high brass for iron boxes.

F. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.
2. Provide suitable expansion fittings where conduits cross expansion joints. Equip these fittings with grounding straps, clamps, and copper bonding jumpers.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Perform all work in accordance with the National Electric Code.

B. Use no conduit less than 3/4-in. in diameter, unless otherwise indicated.

- C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's printed instructions.

3.02 INSTALLATION OF FITTINGS:

- A. Install expansion fittings wherever conduits cross structural expansion joints. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.
- B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.
- C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.
- D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 awg. Install ground wire larger than 12 gauge when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires No. 6 Awg. copper or larger.
- E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.
- F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.
- G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway and suitable for use and location.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.

3.03 INSTALLATION OF RACEWAYS:

- A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with listed bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by hangers and fasteners. Ground raceways by connection to properly grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Install raceways level and square and at proper elevations. Provide minimum 7 ft. headroom.
- B. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, and conduit supports. Provide Type 316 stainless steel nut, bolts, and washers, for use with concrete anchors.
- C. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet on centers.
- D. Provide hot-dipped galvanized supports for galvanized conduit.
- E. Provide sleeves passing through exterior walls and slabs which are wall entrance seals of watertight construction. For new construction, furnish watertight seal between slab and sleeve, and between sleeve and conduit or cable similar to O.Z./Gedney Type "FSK". For existing construction, furnish watertight seal for use in core bit drilled holes that provides seal between concrete and conduit or cable similar to O.Z./Gedney Type "CSM1". Use wall-entrance seals of malleable iron with watertight sealing gland which may be tightened any time after installation.
- F. Do not use dissimilar metals in conjunction with each other. Use an insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.
- G. Install fittings to match raceway being used.
- H. Install expansion fittings wherever conduits cross structural expansion joints at connections between buildings. Keep fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

- I. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.
- J. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box; use two locknuts, one inside and one outside the box.
- K. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- L. Install pull wires in all empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
- M. Complete raceway installation before beginning conductor installation.
- N. Use temporary closures to prevent foreign matter from entering raceway.
- O. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- P. Where metal conduits rise through floor slabs in wet areas, coat conduits for a distance of 6 inches above and below slab grade with brush coat of waterproof bituminous cement.

3.04 BENDS:

- A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit shall have an inside radius of not less than nine diameters.
- B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.
- C. Allow no conduit run to have more than three 90 degree bends or equivalent thereof between pulling points.

3.05 CUTTING, THREADING AND CONNECTING:

- A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with N.E.C.. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors.

Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

3.06 CONDUIT CLEANING:

- A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.
- B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.
- C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.
- D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

3.07 CONDUIT DRAINAGE:

- A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with drain hole at low point.

3.08 INSTALLATION OF BOXES:

- A. Unless otherwise indicated, install sheet metal boxes only in dry, accessible locations. Install cast-metal boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Cast metal boxes shall be used for all surface mounting of wall switches and receptacles and for all outdoor use.
- B. Install boxes in conformance with all the requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.
- C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.
- D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations.

- E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.
- F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

3.09 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT:

- A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.
- B. Install the conduits in locations permitting direct connection to motors.
- C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection.
- D. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets.
- E. Use maximum of 6 feet of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install liquid-tight flexible metal conduit in areas subject to wetting due to fire protection sprinklers or broken or ruptured water line. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

3.10 PROTECTION:

- A. Provide protection and install in accordance with manufacturer printed instructions to ensure that coatings, finishes, and enclosures are without damage or deterioration at completion of project.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.11 FINAL SYSTEM ACCEPTANCE:

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and at no additional cost to the Owner.
- B. Label all raceways and boxes in accordance with the requirements of Section 16050.

3.12 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16120
ELECTRIC WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide wires and cables for complete electrical systems as indicated and specified.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM):
 - B3: Soft or Annealed Copper Wire.
 - B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. The Institute of Electrical and Electronics Engineers (IEEE):
 - 1. IEEE-Std. 48: Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA-70: National Electrical Code (NEC).
- D. Underwriters Laboratories, Inc. (UL):
 - 1. U.L. 44: Wires and Cables Rubber Insulated.
 - 2. U.L. 83: Wires Thermoplastic-Insulated.

E. National Electrical Mfg's Association (NEMA):

1. WC 5: Thermoplastic Insulated Wire & Cable.
2. WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01300 - Submittals:

Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 16050.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 600V Cable:

1. Okonite
2. Southwire
3. American Insulated Wire
4. Or acceptable equivalent product.

B. Control and Metering Wire:

1. Belden Wire and Cable
2. Alpha Wire
3. Coleman Cable
4. Or acceptable equivalent product.

2.02 MATERIALS AND COMPONENTS:

- A. Furnish copper conductors. Material and stranding of conductors to conform to ASTM B3, ASTM B33, and to ASTM B8, for the appropriate class.
- B. Uncoated, soft or annealed copper wire conforming to ASTM B3.

- C. Wires and Cables for Maximum 600-Volt Power Circuits: For #8 and smaller provide type THWN/THHN. Where used in lighting or receptacle branch circuits provide No. 12 and No. 10 as solid conductor. Provide other wire with Class C stranding. Provide No. 6 and larger as XHHW-2 with Class B stranding. Provide wires and cable conforming to UL 83.
- D. Discrete Signals: Single and multi-conductor control cable, copper conductors, Class B or C stranding. Insulation; 600-volt type XHHW-2. Continuous rating of 90C dry and 75C wet. Color coding conforming to Table K-2, NEMA Standard WC-5.
- E. Analog and Communication Signals: Stranded copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinyl chloride. Twist pairs with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket: polyvinyl chloride. Cables: rated 600 volts and 90 degrees C.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Perform work in accordance with the National Electrical Code.
- B. Provide power cable identification to match the existing color coding used in the plant. Below is a normal color code system (verify existing colors before using):

<u>System Voltage</u>	<u>Neutral</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>
208/120V	White	Black	Red	Blue
240/120V	White- Gray Stripe	Black- Blue Stripe	Red- Blue Stripe	None
480/277V	Gray	Brown	Orange	Yellow

- C. Use green to identify insulated ground conductors.

NOTE: Colored insulation, tapes or sleeves may be used to provide color coding. Insulated ground conductors must have green covering.

3.02 INSTALLATION OF WIRING:

- A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.
- B. Number and sizes of wires and conduits indicated are a guide only and are not necessarily correct for the actual equipment installed. Install as many wires and conduits as

necessary for complete electrical system, and provide adequately for the equipment actually installed.

- C. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.
- D. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.
- E. Draw all conductors contained within a single conduit at the same time.
- F. Apply wire pulling compound to conductors being drawn through conduits. Use pulling compound, Minerallac No. 100, Y-er-Eas, Yellow 77, High Performance Polywater Cable Lubricant or acceptable equivalent.
- G. Use no cable bend with radius of less than eight times its diameter.
- H. Wires and cables installed without prior submittal review are subject to removal at no additional expense.

3.03 CONDUCTOR IDENTIFICATION:

- A. Label each wire at both termination points. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.
- B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, self-adhesive, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.
- C. In cases similar to above where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.
- D. In manholes and handholes, identify each power wire by laminated plastic tag located so it is easily seen. Control wires to be bundled and marked as listed in conduit and wire schedule.

3.04 CONNECTORS, TERMINAL LUGS AND BOARDS:

- A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, use self-insulated pressure type connectors for all splices or joints.

- B. Terminate all wires connected to terminal boards, terminal blocks, or to other similar terminals by means of ring and tongue, nylon self-insulated, tin-plated copper pressure terminals.
- C. Terminal boards shall be 600 volts and rated for 125% of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type, as necessary.
- D. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:

10AWG and smaller: Use self insulated pressure-type connectors.

8AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.

- E. Clearly and permanently mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams wherever possible.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide field test, and place in operating condition, wiring devices as indicated and specified.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. National Electrical Manufacturers Association (NEMA):
 - 1. National Electrical Code (NEC).
- B. Federal Specifications:
 - 1. W-S-896-F (1P-2P-3W) Switch, Toggle, Single Unit with wall plates.
 - 2. W-C-596-F Plug, Electrical Connector, Receptacle, Electrical.
- C. Underwriters' Laboratories, Inc. (UL):
 - 1. UL-20, General Use Snap Switches.
- D. National Fire Protection Association (NFPA):
 - 1. National Electrical Code (NEC).

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 16050.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

- A. Manufacturers acceptance contingent upon products compliance with specifications.
- B. Provide all devices with U.L. label.

2.02 MANUFACTURERS:

- A. Arrow-Hart, Inc., Florence, KY.
- B. Allen-Bradley Co., Milwaukee, WI.
- C. Appleton Electric Co., Chicago, IL.
- D. Bryant Electric, Div. of Westinghouse, Bridgeport, CT.
- E. Cutler Hammer, Inc., Milwaukee, WI.
- F. Crouse-Hinds Co., Syracuse, NY.
- G. Harvey Hubbell, Inc., Bridgeport, CT.
- H. Pass & Seymore, Inc., Syracuse, NY.

2.03 MATERIALS AND COMPONENTS:

- A. Wall Switches:
 - 1. Provide alternating current, general-use, snap switches, in flush device boxes or on outlet box covers, totally enclosed in composition case, with insulated mounting yoke and sidewired, binding screw-type terminals. Single-pole, 2-pole, 3-way, or 4-way switches rated 20 amperes at 120/277 volts a.c. Switch to meet Fed. Spec. W-S-896-F and UL-20.
 - 2. Switches for controlling lighting:
 - a. Harvey Hubbell Cat. No. 1221, 1222, 1223 or 1224.
 - b. Bryant Electric Cat. No. 4901, 4902, 4903 or 4904.
 - c. Pass & Seymore, Cat. No. 20AC1, 20AC2, 20AC3 or 20AC4.
 - d. Or acceptable equivalent product.

B. Watertight Switches:

1. Provide watertight switches consisting of flush mounting switches in NEMA Type 4 gasketed cast metal boxes. Switch operable through shaft in matching cast metal cover, twenty-ampere, 120/277-volt switch enclosures:
 - a. Crouse-Hinds Type MC or MCC.
 - b. Allen-Bradley Cat. No. 600-TCX-4.
 - c. Cutler-Hammer Cat. No. 9101 H98.
 - d. Or acceptable equivalent product.

C. Special Receptacles:

1. Provide weatherproof devices rated 20 ampere, 125-volt, consisting of single receptacles with spring-loaded, soft-gasketed hinged covers with stainless steel spring. Covers as follows:
 - a. Arrow-Hart Cat. No. 4500FS.
 - b. Harvey Hubbell Cat. No. 5206.
 - c. Bryant Electric Cat. No. 4510.
 - d. Crouse-Hinds Cat. No. WLRS-1.
2. Provide in corrosive areas (NEMA 4X) a receptacle similar to the weatherproof device described above. Cover as follows:
 - a. Crouse-Hinds Cat. No. WLRS-1-S752.
3. Provide watertight, gasketed cast-metal enclosures with covers in areas subject to hose-down, meeting requirements, and either standard single or duplex type:
 - a. Appleton Electric Cat. No. AEE3382 and AEP3361, Style 2.
 - b. Crouse-Hinds Cat. No. ARRH33 and APJ3385, Style 2.
4. Provide receptacles with matching plug or cord cap designed to meet NEMA 4 requirements when plug, cord and receptacle are assembled.

D. Outlet Boxes and Enclosures:

1. Provide outlet boxes and enclosures conforming to Section 16110, Electrical Raceway Systems and enclosure schedule on the drawings unless otherwise indicated.
2. Weatherproof receptacles shall have covers that are approved for unattended operation (receptacle is covered with plug installed).

E. Device Plates:

1. Provide device plates suitable for type of outlet boxes and enclosures used. Plates for flush-mounting by device manufacturer. Plates for surface-mounting boxes by either device manufacturer or box manufacturer.
2. Provide flush device plates of high corrosion resistant, Type 302 stainless steel.
3. Provide flush device plates of material and finish indicated, in certain designated areas.

F. Nameplates:

1. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. Do not use ON and OFF for 3-way or 4-way switches. Receptacles for special purpose shall have nameplates indicating their use, unless use is obvious. Nameplates shall otherwise conform to requirements specified under Section 16050.

PART 3 - EXECUTION

3.01 CONNECTION:

- A. Securely and rigidly attach wiring devices in accordance with regulating agency, and as indicated, avoiding interference with other equipment.
- B. Securely fasten nameplates using screws, bolts, or rivets and centered under or on the device, unless otherwise indicated.

3.03 GROUNDING:

- A. Ground switches and their metal plates through switch mounting yoke, outlet box, and raceway system.
- B. Ground flush receptacles and their metal plates through positive ground connection to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw, or by grounding jumper, both making positive connection to outlet box and grounding system at all times.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16160

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide panelboards including circuit breakers and cabinets complete, as indicated and specified.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. National Electrical Manufacturers Association (NEMA):
 - 1. PB1- Panelboards
 - 2. AB1- Molded Case Circuit Breakers
- B. Federal Specifications (FS):
 - 1. W-P-115A - Panel, Power Distribution.
 - 2. W-C-375B - Automatic Circuit Breakers.
 - 3. QQ-S-365B - Silver Plating, Electro deposited, General Requirements for
- C. National Fire Protection Association (NFPA):
 - 1. National Electrical Code (NEC)
- D. Underwriter's Laboratories, Inc.:
 - 1. UL 67 - Panelboards

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 16050.

PART 2 - PRODUCTS

2.01 PANELBOARD MANUFACTURERS:

- A. Manufacturers acceptable contingent upon products' compliance with the specifications:
 - 1. General Electric Company
 - 2. Square D Company
 - 3. Cutler-Hammer Products
 - 4. Siemens

2.02 PANELBOARDS:

- A. Factory assembled deadfront type panelboards.
- B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs only as indicated.
- C. Furnish panelboards with full capacity separate ground bus, separate insulated neutral bus and furnish panelboards connected to a 3-phase, 4-wire service or single phase, 3-wire service as indicated.
- D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. U.L. 67, and the N.E.C.
- E. Furnish the panelboard main and neutral buses, with minimum 98 percent conductivity rectangular copper bars provided with bolted type lugs as necessary.
- F. Drill buses to fit either "A", "B" or "C" Phase connectors, and ensure that connectors are inter-changeable and installed in a distributed phase sequence.
- G. Silver plate buses, connectors and terminals to a minimum thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.
- H. Prevent terminal lugs from turning per NEMA standard PBI and ensure they are suitable for the conductor material and size.
- I. Provide main bus-bracing for each panel board adequate for 10,000 amperes symmetrical short circuit at 240 volts and 42,000 amperes symmetrical short circuit at 480 volts unless otherwise indicated.

2.03 CIRCUIT BREAKERS:

- A. Furnish bolt-on type branch and main circuit breakers. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1
- B. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.
- C. Do not use single pole breakers with handle ties or bails in lieu of multipole breakers.
- D. Furnish handle lock device on breakers as indicated to prevent the manual opening of the selected breakers.
- E. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated
- F. Furnish ground fault interrupter circuit breakers for certain circuits as indicated on the drawings.
- G. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

2.04 CABINETS:

- A. Provide NEMA 4 cabinets, unless otherwise indicated and without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.
- B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.
- C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78-in. (1980 mm) in height.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Mount panelboards such that the height of the top operating handle does not exceed 6 ft. 6-in. (1980 mm) from the floor.
- B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.
- C. Provide directory card filled-out.

3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16402

UNDERGROUND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete underground distribution system as indicated and specified.
- B. Conform to lines, grades, elevations, and dimensions. Resolve interferences with other underground conduit, piping or equipment, either new or existing with the Engineer. Match components suitable for proper installation.
- C. Provide concrete encasement of duct system where indicated. Include forms and reinforcing in installation. Perform work in accordance with Section 16050.
- D. Provide handholes complete with ground rods, windows, frames, covers, cable racks, supports, pulling irons, and other inserts. Use reinforced concrete. Perform work in accordance with Section 16050.
- E. Provide Schedule 40 polyvinylchloride (PVC) conduit for power and fiber optic control circuits and furnish and install rigid galvanized steel conduits for instrumentation, communication and fire circuits.

1.02 RELATED WORK:

- A. Section 02210: Earth Excavation, Backfill, Fill and Grading
- B. Section 03100: Concrete Formwork
- C. Section 03200: Concrete Reinforcement
- D. Section 03300: Cast-in-Place Concrete
- E. Section 16050: Electrical Work - General
- F. Section 16110: Electrical Raceway System
- G. Section 16120: Electric Wires and Cables
- H. Section 16450: Grounding

1.03 REFERENCES:

- A. National Fire Protection Association (NFPA):

1. NFPA-70: National Electrical Code (NEC).

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 1. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 16050.
 2. Provide "As-Built" drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

- A. Manufacturer's acceptance contingent upon products' compliance with specifications.

2.02 MANUFACTURERS:

- A. Polyvinylchloride (PVC) Conduit:

1. Specified in Section 16110.

- B. Rigid Steel Conduit, Galvanized:

1. Specified in Section 16110.

2.03 MATERIALS AND COMPONENTS:

- A. Conduit Spacers: Furnish conduit spacers made of plastic to maintain spacing between conduits.
- B. Concrete: Minimum compressive strength, 3,000 psi (210 kg per square centimeter).
- C. Handhole Frames and Covers:
 1. Materials: Steel, hot-dipped galvanized.
 2. Cover Type: Solid, hinged, of checkered design.
 3. Cover Loading: H-20.
 4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:

a. ELECTRICAL.

a. SIGNALS.

D. Furnish knockout for ground rod in each handhole.

E. Manufacturers:

1. Brook Products, Inc.
2. Penn-Cast Products, Inc.
3. Associated Concrete Products, Inc.
4. Utility Vault Co.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUITS:

- A. Duct banks are to be formed, unless trench conditions allow for neat placement of concrete with specified clearances.
- B. Install duct banks a minimum of 12-inches from parallel pipes, lines, structures. Provide a minimum of 6-inch separation between crossing ducts. Do not allow the top of concrete to be less than 12-inches below finished grade or paving.
- C. Provide handholes where indicate and as required to install wiring without damaging insulation or stretching conductors.
- D. Lay ducts with a minimum slope of 2 inches per 100-feet and slope to handholes and away from buildings.
- E. Accomplish changes in direction of runs exceeding total of 10 degrees, either vertical or horizontal, by long sweep bends having minimum radius of curvature of 25 ft. Manufactured bends can be used at ends of short runs of 100-ft. or less, and then only at or close to the end of run. Provide long sweep bends made up of one or more curved or straight sections. Install manufactured bends with minimum radius of 36-in. where larger radius cannot be used.
- F. Install duct spacers at intervals of approximately 4 feet and stagger 12 inches or more between tiers of ducts. Install bottom spacers to provide at least 3-inches between bottom of trench and underside of bottom conduits. Firmly wire conduits and spacers together and hold ducts in place to prevent floating or accidental movement before concrete is

placed.

- G. Stagger joints in conduits at least 6-inches.
- H. Where indicated, provide steel reinforcing.
- I. Prior to placing concrete, remove dirt, sand, and other debris from between conduits and from trench bottoms. Completely fill space with concrete.
- J. Do not use power-driven vibrators for spading of concrete around ducts.
- K. Backfill duct bank in layers and tamp or "puddle" (Division 2 Work). Provide yellow duct bank marker tapes, reading "Caution - Electrical Lines Below", over entire length of duct line. Locate tapes 12 inches below grade. Provide a tape for every 12 inches of width of ductline.
- L. Roll and grade backfill, and restore surface to condition equal to the site finished grade, or as otherwise indicated (Division 2 Work).
- M. Keep ducts clean of concrete, dirt, and other substances during the course of construction. After the ducts have been completed, pull a standard flexible mandrel not less than 12-inch long, having a diameter approximately 1/4-inch less than the inside duct diameter through each duct, then pull a brush with stiff bristles through each duct to make certain that no particles of earth, sand, or gravel remains in the line. Replace conduit runs that do not allow the passage of the mandrel at no additional cost to the Owner. Pneumatic rodding may be used to draw in the lead wire. Install in spare conduits a pull line, and plug and seal spare conduits after cleaning.
- N. Lay conduits, indicated to be direct buried in the ground, in trench on 3-inch bed of sand and cover with an equivalent 3-inch bed of sand. Ensure that no rocks come in contact with conduit during backfilling. Dig trenches to depth and location indicated.
- O. Provide minimum separation of power and control conduits of 3 inches both vertically and horizontally. Build ductbank layer by layer, backfill and compact each layer to provide support for next layer.
- P. Separate power and control ducts from instrument ducts by a minimum of 12 inches.
- Q. Install conduit, indicated to be encased in concrete with spacers and reinforcing, as specified and as indicated. Rigid galvanized steel conduits to be painted with bituminous paint.
- R. Install conduit runs following routing on drawing and running in straight lines. Where deviation from a straight line becomes necessary, install bends of radius which allow for rodding and installation of cable.

3.02 HANDHOLES:

- A. Construct handholes of 3,000 psi concrete cast in place, as indicated.
- B. Place a 6-in. crushed-stone base under each handhole.
- C. Construct cast-in-place handholes with forms, complete with centering cores and molds, to conform to shape, form, line, and grade required and maintain sufficiently rigid to prevent deformation under load. Make all joints leakproof and arrange horizontally or vertically. Place forms on successive units for continuous surfaces and fit to accurate alignment, assuring a smooth completed surface, free from irregularities.
- D. At convenient point close to wall, drive a ground rod into earth as indicated. After completion of handhole, connect 6 foot length of No. 4 bare copper ground wire to ground rod and coil it within handhole for connection to steel supports and cover.
- E. Set handhole frames to the required grade, in full bed of concrete mortar to make watertight connection.
- F. Install tops of handhole covers in unpaved areas approximately 1/2-in. above finished grade, and in paved areas install flush with finished surface of paving.
- G. Install galvanized corrosion-resistant channel support, with continuous slot and required fittings designed for concrete encasement.

3.03 HANDHOLE WATERPROOFING:

- A. Apply two coats of bituminous waterproofing material to exterior surfaces of handholes. Apply by brush or spray, in accordance with manufacturer's printed instructions. Allow time between coats to permit sufficient drying.
 - 1. Two coats applied with a minimum dry film thickness of 12 to 14 mils per coat.

3.04 RECORD DRAWINGS OF UNDERGROUND WORK:

- A. Furnish one set of marked copies of contract drawings, showing exact routing and depths of all underground conduit, duct handholes. Furnish scaled plot plans, showing principal outline of buildings and structures. Reference conduits, ducts, and all bends deviating from straight line, dimensionally from fixed objects or structures.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide a single, complete, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the National Electrical Code Article 250 and the National Electrical Safety Code.
- B. Include grounding of, electric equipment enclosures etc., ground grid systems with ground rod; structural steel, and lightning protection system.
- C. Include grounding conductors completely interconnecting water supply pipe, ground rods, ground grid, buses, other distribution equipment, and other groundable equipment.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. American National Standards Institute (ANSI):
 - 1. ANSI-C2: National Electrical Safety Code.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA-70: National Electric Code.

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 16050.
 - 2. Submit information on:
 - a. Ground rods

- b. Exothermic welding
- c. Connecting hardware

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

- A. Manufacturer's acceptance contingent upon products' compliance with the specifications.

2.02 MANUFACTURERS:

A. Ground Rods:

- 1. ERICO Products Inc.
- 2. Galvan Electrical Products
- 3. Nehring Electrical Works
- 4. Or an acceptable equivalent product.

B. Exothermic Welding:

- 1. ERICO Products, Inc.
- 2. American Brass Mfg. Co.
- 3. Orgo-Thermit, Inc.
- 4. Or an acceptable equivalent product.

C. Connecting Hardware:

- 1. American Brass Mfg. Co.
- 2. Thomas and Betts
- 3. Anderson Electric Corp.
- 4. Or an acceptable equivalent product.

2.03 MATERIALS AND COMPONENTS:

A. Conductors:

1. Provide copper grounding conductors bare or insulated, sized as indicated or as required by the NEC. Minimum bare conductor size shall be No. 2 AWG. Provide protection of conductors if physical damage would result from direct exposure.
2. Provide bare conductors where conductors are buried in the earth or where they are embedded in the concrete.
3. In buildings, provide insulated grounding conductors with green insulation. Provide insulated grounding conductors with insulation rated at 600 volts.

B. Ground Bus:

1. Provide a 2-in. by 1/4-in. copper bar complete with bolted type connectors as indicated.

C. Ground Rods: Provide 3/4-inch diameter, 20-foot long copper-clad steel ground rods where indicated. Where rock is encountered, grounding plates may be used in lieu of grounding rods.

D. Connections:

1. Provide silicon bronze ground clamps for use on copper or brass pipes which are U.L. listed.
2. Provide ground clamps, for use on iron pipes, of galvanized or malleable iron, or of standard noncorrosive material.
3. Furnish ground clamps, for use on pipes, with rigid metal base providing good contact by proper seating on the pipe. Do not use strap type clamps.
4. Provide copper-clad steel ground rods; type, diameter and length as indicated on drawings. Make cable to ground rod connection without passing over end of ground rod.

PART 3 - EXECUTION

3.01 INSTALLATION OF GROUNDING CONDUCTORS:

- A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.
- B. Run grounding conductors associated with concrete ductbank in common trenches.

- C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.
- D. Where raceways are used to contain and protect grounding conductors, install in accordance with Sections 16110 and 16402.
- E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.
- F. Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.
- G. Connect structural steel to an external perimeter loop of grounding conductor installed around all sides of building foundation, buried at least 30 inches below grade, and connect to each vertical column by loop or tap. Exothermic weld connections. Connect two opposite points on external loop to two different points on grounding system.
- H. Buried and concealed ground connections shall use exothermic welding.
- I. Make accessible connections to structural members by exothermic welding process or by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.02 INSTALLATION OF GROUND RODS:

- A. Install ground rods in manholes in accordance with requirements specified under the section Underground Distribution Systems. Connect each grounding conductor entering a manhole to ground rod by exothermic weld.
- B. Install ground rods where indicated. Install the top of the rod 12-in. below the ground surface.
- C. Make connection to overall grounding system as indicated.
- D. Ensure that final resistance of interconnected ground system is 5 ohms, or less. Measure ground resistance in normally dry conditions, and not less than 48 hours after rainfall.

3.03 EQUIPMENT GROUNDING:

- A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600-volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.

- B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.
- C. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.
- D. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run.
- E. Install a separate grounding conductor from ground system to motors of 100 hp. and larger, in addition to raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.
- F. Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system. Mount ground bus on 600v pedestal insulators.

3.04 SIGNAL GROUNDING:

- A. Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.
- B. Where convenient several signal bonding conductors may be combined, providing that all the following conditions are met:
 - 1. The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.
 - 2. The combined signal bonding conductor shall be isolated from the equipment grounding conductor.
 - 3. Where two signal bonding conductors are combined use a three port insulated splice.
 - 4. Where three or more signal bonding conductors are combined, use a copper bus mounted on 600V insulators. Attach each conductors to the bus using an insulated ring tongue lug and screw terminal.

3.06 TESTS AND CHECKOUTS:

- A. Testing shall not be performed within 48 hours of rainfall. Dry season resistance of each electrode(s) shall not exceed 5 ohms. If such resistance cannot be obtained with the system as installed, additional grounding rods shall be provided as required.
- B. Furnish copies of test reports on ground system.

3.07 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16900

ELECTRICAL CONTROLS AND MISCELLANEOUS ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and connect the electrical control equipment and miscellaneous electrical equipment, including such instruments and devices indicated and specified. Device enclosures for electrical equipment as indicated and specified.
- B. Control panel enclosures and devices specified herein are provided under those specification sections which invoke this section for control panel requirements or as indicated on electrical drawings.

1.02 RELATED WORK:

- A. Section 13300: Utility Control Instrumentation System.
- B. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. Underwriter's Laboratories, Inc. (U.L.):
 - 1. UL-467: UL Standard for Safety, Grounding and Bonding Equipment.
 - 2. UL-489: UL Standard for Safety, Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. 250: Enclosures for Electrical Equipment (1000 volts maximum).
 - 2. ICS 1: General Standards for Industrial Control and Systems.
 - 3. ICS 2: Industrial Control Devices, Controllers and Assemblies.
 - 4. ICS 4: Terminal Blocks for Industrial Use.
- C. National Fire Protection Association (NFPA):

1. NFPA-70 National Electric Code (NEC).

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01300 - Submittals:

1. Submit shop drawings and manufacturer's product data, brochures including wiring diagrams in accordance with Section 16050.
2. Wiring diagrams to show control interface points provided with other equipment.
3. Shop drawings to include:
 - a. Outline drawings with elevations.
 - b. Equipment arrangement drawings.
 - c. Anchor bolt location drawings.
 - d. Electrical schematics and wiring diagrams.
 - e. Electrical fuse/circuit breaker characteristic.
 - f. Equipment performance curves and data.
 - g. Bill of installation/assembly materials.
 - h. Equipment weights.
 - i. Completed manufacturer's data sheets.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01400.

PART 2 - PRODUCTS

2.01 ELECTRICAL DISTRIBUTION MANUFACTURERS:

- A. Siemens.
- B. General Electric Company.
- C. Cutler-Hammer.
- D. Square D Company.
- E. Appleton Electric Company.
- F. Crouse-Hinds Company.
- G. O-Z/Gedney.
- H. Or acceptable equivalent product.

2.02 STAINLESS STEEL CHANNEL MANUFACTURERS:

- A. Unistrut Corp.
- B. Power-Strut.
- C. B-Line Systems, Inc.
- D. Or acceptable equivalent product.

2.03 CONDUIT AND WIRING:

- A. Provide conduit and wiring necessary to make connections between instrument panels, consoles, cabinets and external equipment and devices.

2.04 CONTROL PANELS AND ELECTRICAL ENCLOSURES:

- A. Provide control panels for RTU and other equipment, as specified and indicated. Ensure that dimensions, NEMA rating, construction and mounting of equipment is as indicated.
- B. Provide enclosures with back panels constructed of at least 14 gage steel and provided with terminal blocks for connection of external wiring. Provide door and body stiffeners in panels over 36 inches [3 meters] in length. NEMA 4 and NEMA 4X panels to be provided with hand operated quick disconnects of stainless steel material.
- C. Provide UL listed and NEMA rated pushbuttons, indicator lights and switches of heavy duty, oil tight types. Provide relays of industrial types, with 120-volt, 60-Hertz operating coils, and contacts rated for intended service. Power from fused control power transformers.
- D. Provide nameplates for each panel and each device on panel. Nameplates of laminated plastic material, at least 3/32 in. thick, and with white letters on a black background.
- E. Secure nameplates with 3M VHB assembly tape.
- F. Terminal Blocks:
 - 1. Provide terminal blocks rated for 600 volts with screw type terminals.
 - 2. Terminal blocks to be one piece with full barriers.
 - 3. Provide General Electric EB-25 terminal blocks or equal.
- G. Provide print pocket on inside of enclosure and include as-built drawings for Owner's use.
- H. Where 480V AC and 120 VAC are required within the same enclosure, install components to insure separation of wiring for the panel voltage circuits.
- I. Provide enclosures as manufactured by McKinstry Incorporated, Hoffman, Inc., or Hammond Manufacturing.
- J. Enclosures 24 inches [2 meters] high or larger shall be provided with light fixtures, light switch and 20 amp GFI protected receptacle. Light fixtures shall be UL listed for wet locations and provided with glass globe, metal guard and 100 watt incandescent lamp.
- K. All indicating lamps to be LED cluster type.

2.06 PUSHBUTTON AND SELECTOR SWITCH STATIONS:

- A. Provide HAND-OFF-AUTO switches, push buttons, tumbler switches and other accessory devices as necessary for the control of motors and other electrical equipment or devices.
- B. Provide pushbutton and selector switch stations designed for heavy-duty service and with momentary or maintaining contacts as indicated or as necessary for starting and stopping of equipment with 10 amp contact ratings.
- C. Provide heavy duty switches and pushbuttons, Square D Class 9001, or approved equal. Indicating lights to be led cluster type.
- D. At stations provide nameplates with white letters on black background.
- E. Provide safety lockout station with position indication located near motor to prevent application of current.
- F. Provide galvanized cast-iron enclosures for NEMA Type 4 watertight stations.

2.07 NAMEPLATES:

- A. Provide nameplates for equipment (including pushbutton and selector switch stations) listed in this section and other controls furnished under this contract, to designate the equipment controlled and their function.
- B. Nameplates shall be laminated black bakelite with one-quarter inch (1/4-in.) high, white, recessed letters. Securely attach to the equipment with Type 316 stainless steel screws, or rivets. Adhesives, glue or cements will not be permitted.
- C. Provide all junction boxes, pull boxes, disconnect switches and control panels with a nameplate to designate the system wiring contained within.
- D. Install nameplates in a location near or on the equipment or devices.

2.07 CHANNEL:

- A. Provide Type 316 stainless steel channel with corresponding accessories.

PART 3 - EXECUTION

3.01 WIRING OF MISCELLANEOUS DEVICES:

- A. Make electrical connections required for recording and indicating instruments, and miscellaneous devices. Provide electrical supplies to instrumentation and control systems.
- B. Install conduit and wiring and make electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices. Panels, cabinets, etc., are indicated.

3.02 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS:

- A. As specified in Section 16050, install conduit, wiring, and connections for equipment and devices furnished under other Sections of specifications, and as indicated.
- B. Refer to mechanical specifications and drawings for locations of level transmitter, float switches, butterfly valves, solenoid-operated valves, control panels, alarm actuating contacts, indicating lamps, limit switches, and other devices requiring wiring or interconnections with equipment supplied under Electrical Sections of these specifications.

3.03 CHANNELS:

Install Type 316 stainless steel for mounting of electrical equipment.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16999

FIELD ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. After electrical installation is complete, perform tests to demonstrate that entire system is in proper working order and in accordance with drawings and specifications. Do not perform tests less than those outlined hereafter, unless requested in writing and approved by Engineer. Tests are in addition to, and no substitution for, tests of individual items at manufacturer's plant. Perform insulation and ground resistance tests before operating tests. Determine proper rotation of motors before permanent connections are made.
- B. Pay all costs for tests including expenses incident to retests occasioned by defects and failures of equipment to meet specifications.
 - 1. Replace wiring and equipment found defective, or failing to meet specified requirements, at no additional cost, unless written acceptance for repair is given by Engineer.
 - 2. Furnish three copies of all test results to Engineer.
 - 3. Unless otherwise specified, Owner will supply electric current for tests.

1.02 REFERENCES:

- A. NEMA: National Electrical Manufacturers Association, 2101 L Street, Northwest, Washington D.C.
- B. IEEE: Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, NY.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01300 - Submittals:
 - 1. Submit data sheets for the insulation resistance testing of conductors and motors prior to performing operating testing.
 - a. List all cables and motors to be tested.

- b. Provide space on data sheets to enter the results of testing, instruments used with serial numbers, and name of personnel performing testing. This data to be filled out during testing in the presence of the Engineers.
2. Submit data sheets for ground system testing.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT:

A. Calibration:

1. Furnish applicable electrical instruments including voltmeters, ammeters, wattmeters, tachometers and all other equipment required to perform tests specified. Furnish certified copies of calibration curves of these instruments which have been calibrated for specific tests. Provide these instruments as directed by the Engineer during performance of operating tests.
2. Make openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, for the tests. Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.
3. Other sections of specifications require services of one or more manufacturer's representatives, to ensure that equipment supplied has been installed properly and adjusted to proper working order. Advise representative of applicable tests in this Section, so that work will be coordinated, and tests combined where feasible.

2.02 TESTING:

A. Coordination:

1. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and other requirements of Section are carried out on timely, coordinated basis.
2. Conduct tests in presence of Engineer. Notify Engineer seven calendar days or more in advance when any test is to be performed, and do not start tests without Engineer's permission.

PART 3 - EXECUTION

3.00 INSTALLATION VERIFICATION:

- A. Open all electrical equipment enclosures for inspection by the Engineers.

- B. Remedy all installations which do not conform to NEC criteria or show evidence of poor workmanship.

3.01 INSULATION RESISTANCE TESTS OF CIRCUITS, 600 VOLTS AND BELOW:

- A. Do not subject conductors rated 600 volts and below to high potential dielectric tests. Test each complete feeder and branch circuit of 600 volts or below with everything but power supply and power-consuming equipment, connected thereto, and have an insulation resistance between conductors and between each conductor and ground of not less than 1,000,000 ohms, unless otherwise accepted by Engineer.
- B. Determine insulation resistance values with switchboards, panelboards, fuseholders, switches, receptacles, and overcurrent devices in place.
- C. Use megohmmeter having output of at least 500 volts to determine insulation resistance value for 600 volt rated conductors.
- D. List each circuit and measured resistance as test data on data sheets as described in paragraph 1.03.
- E. Maintain written record of all insulation resistance values. Identify conductor, or equipment, date that value was taken and resistance value. Arrange information in suitable neat tabular form and submit to Engineer in triplicate.

3.02 OPERATING TESTS:

- A. Operate each motor and associated equipment, as nearly as possible, under normal operating conditions for length of time sufficient to demonstrate correct alignment, temperature rise, speed, and satisfactory operation. Load motors to full capacity, or as near as possible.
- B. Provide electrical test instruments as directed by the Engineer and specified in paragraph 2.01 A.1, to measure circuit voltage, current and harmonics.
- C. Operate switches, circuit breakers and control devices to verify correct operation.
- D. Associated equipment includes instruments, meters, relays, circuit breakers, switches, and other devices in substations, switchgear, motor control centers, panelboards, control and instrumentation panels, related to motor being tested.
- E. Where tests of any of above-referenced equipment included in other Sections of specifications, coordinate testing, as directed by Engineer, to avoid duplication and conflict between tests.

- F. Perform above tests in addition to, and not in substitution for required manufacturer's factory tests of individual items.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION